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HABITS OF THE WHITE-TAILED KITE

BY ROBERT T. MOORE AND ARTHUR BARR

Plate 16

As several articles have been written about the White-tailed Kite (*Elanus leucurus majusculus*) the authors have condensed and combined their notes to give the salient features in one paper. Responsibility for each observation is shown by reference to numbered paragraphs (senior author responsible for paragraphs 4, 5, 6, 7, 10, 13, 14; junior author responsible for paragraphs 1, 2, 3, 8, 9, 11, 12).

(1) The nest was found in southern California by Mr. James Dixon of Escondido. On April 2, 1939, his son, Ralph Dixon, the junior author and two friends, James Fassero and Gus Hanson, visited the nest and found that it contained eggs, which could not be seen clearly through the limbs by Ralph, who believed they were four in number. On April 16, Ralph again climbed the tree and reported that the eggs had hatched, and that there were three young in the nest. A special forty-foot ladder was guyed straight into the air, fifteen feet away from the nest on April 23 and a crate, formerly used for shipping a refrigerator, was placed without camouflage on top of it. On April 30, the senior author, as return courtesy for the loan of equipment, was invited to join the party. Ascending a second forty-foot ladder fastened to the main one, so that it extended obliquely toward the nest, the junior author obtained the first unobstructed view of the young and discovered that there were only two remaining.

(2) At this time the young were approximately two weeks old. They were covered with a slate-blue down, the eyes were light brown, the feet pale flesh-color and the inside of the mouths unusually pink. The nest was lined with grass and a considerable amount of fur from meadow mice (*Microtus californicus sanctidiegi*). When the junior

author looked over the edge of the nest, the young birds lay flat, but when they saw him, they raised the fore parts of their bodies and thrust their heads into the air, opening their mouths without making any sound. At this time, the parents were observed on top of a cottonwood tree at a considerable distance and they, too, gave no calls whatever.

(3) The first observations, which differ from those made by other observers, were connected with the pellets. On April 30, the junior author found several of them, as well as the partly eaten body of a mouse and a lizard, under a tree situated about a hundred yards from the nest site. This tree was used repeatedly by both adult hawks as a point of observation when approaching the nest and it also seemed to have been employed as a roosting locality. The pellets were extraordinarily large, but in view of the fact that since this article was begun, the measurements of pellets have been given elsewhere (Condor, 42: 106–111, 1940), my data, which conform quite closely to those of the author, will not be inserted here. On May 4, a pellet and several kite feathers were picked up *inside* the blind itself. At this time the junior author believed that these had been left by other members of the photo squad. Subsequently, on May 6 and 7, when James Fassero visited the nest, he found a pellet, a headless *Microtus* and more feathers of the kite in the blind-box! A comparison of notes and the elimination of all possibilities that the pellets might have dropped from the pockets of one of the observers, convinced us that the adult kites had actually been using the blind as a roosting place at night. After completing feeding on the 4th, the female picked up a pellet from the bottom of the nest and flew with it, dropping it a short distance away. She did the same with several other things the identity of which could not be determined. Mr. Fassero stated that both young birds were in the nest on the evening of the 6th, but on the morning of the 7th, only one remained. Search by him in the vicinity failed to discover the hawklet.

(4) On May 9, the senior author spent six hours consecutively at the top of the ladder. The following is a condensation of his notes, made in the 'refrigerator' blind, slightly above and fifteen feet away from the kites' nest. "From this point of vantage, I can look down into the structure built by the hawks, as well as far over the rolling countryside of southern California. Mr. Barr and I are particularly favored, as no other previous observers seem to have been favored, first, in having an opportunity to watch White-tailed Kites from a close point of vantage; second, in having our uncamouflaged

blind immediately accepted by the hawks. The nest, approximately the size of the slightly concave platforms built by crows, consists of sticks and is placed on a slender arching limb of a cottonwood, thirty-five feet from the ground. It is one of the most southern trees of a strip of woodland three miles long, which parallels a small river a half-mile to the north. These trees are scattered somewhat far apart and, besides the cottonwoods, consist chiefly of willows. There is the usual accompaniment of low bushes, long grasses and swampy areas. Bordering our woodland on the south and not three hundred feet away stretches the undulating ploughed land of a huge farm. Here and there are scattered tufts of grass and farther away a larger grassland, into which the kites drift down with their slow stoops to catch mice for their offspring. On the night of the 6th, one of the two remaining hawklets disappeared, possibly by human agency, but another explanation seems more plausible. That morning was one of heavy wind. It is still blowing so hard while I am taking my pictures, that the remaining bird is in danger of being blown into space. Repeatedly he (masculine pronoun used for convenience) has saved himself by catching his talons into the far rim of the platform. This danger threatens, whenever he tries his setting-up exercises. These consist of raising the wings at various angles as far as they can be stretched. The hawklet seems to have no instinctive feeling of how to protect himself against the wind; indeed, when a gust comes suddenly, he foolishly throws up a wing on the side toward the blow in an endeavor to maintain balance, which results in giving it a better chance to unbalance him. Then the other wing shoots upward and the bird is carried across the nest. A purposeful crouching with wings folded never seems to be foreseen as a safeguard against the gusts, but experience or instinct does bring the talons to the rescue at the proper moment. The literature of the kite indicates that it prefers rolling country, where moderately strong winds blow, sufficient to afford opportunity for the famous aërial maneuvers. From nests in such exposed localities no doubt many young are carried away."

(5) Pickwell (Condor, 32: 223, 1930), Peyton (Condor, 17: 231, 1915), and others have recorded that kites do not object to pairs of the same species building within two hundred yards of their own nest, apparently lacking the need for the defense mechanism of territorialism, but they are said to be distinctly hostile to many of the larger *Buteos* and specifically to crows. Our experience confirms these reports. I observed a kite dive several times at a crow, which was obviously more afraid of it than of the preceding stoop of a

Kingbird, for this time the crow rolled over into the air to defend itself. Arthur Barr noted that the kites attacked a pair of Red-bellied Hawks, when either of them came close to the nesting-tree. My notes continue: "On the other hand, kites seem to distinguish between friends and enemies, for they have permitted three other species of birds of diverse character to nest in this same tree. One is a sparrow hawk, whose three eggs are deposited in a rusty can six feet from the ground, nailed to the trunk below me. One attack on the sparrow hawks has been recorded by Arthur Barr, and similar attacks may have deterred them from incubating. Some days ago, the sparrow hawks abandoned their nest, but continue to fly by the old can occasionally. More surprising is the location of a Bullock's Oriole's nest not eight feet away and on the same level with the kites' platform. Both adults take turns incubating in the fluffy creation and alternately hunting for bits of adornment even in the kites' nest, which the young kite halts by rising with open bill. The fourth pair of the tree's denizens really astounds me, because I have never known *Tyrannus* of the East to permit other species even to approach his nesting-tree. But here twenty feet below the kites' nest and about nine feet above that of the sparrow hawks is a nearly completed structure of the Western Kingbird (*Tyrannus verticalis*). These birds are moving in and out of the tree every few minutes carrying material for their white-lined nest. Furthermore, a fifth pair of birds, Western House Wrens, are constantly carrying nesting material to a hole on the trunk of the tree next to the kites, twenty feet to the west. During all the hours Arthur and I have watched from this blind and in the vicinity, not once have we observed the kingbirds launch an assault from the nest-tree on any other species. And yet, their food area, consisting of low shrubs two hundred yards away, is deemed such sacred territory that they do not permit even the kites to cross it at an altiude lower than 500 feet, although they will permit them to feed young within twenty feet of the kingbirds' nest!"

(6) Few authors have described the sexes of the adults as differing and neither Sharpe (Cat. Birds British Mus., 1: 339–340, 1874) nor the latest monographers, Swann and Wetmore (Monograph Birds of Prey, pt. 13: 267, 1935) make any distinction between them. Hoffman (Birds of the Pacific States, p. 64) declares that the female has "the white of head and breast duller." In our pair the female was darker gray above and the dark marks on the wing were blacker. The male appeared to be very white, especially lighter colored above. A fortunate observation made it possible to distinguish the sexes.

On one occasion I watched with the aid of a powerful binocular, both birds sitting side by side for one whole hour on the lookout-tree. Suddenly the whiter bird flew into the air and then settled down on top of the darker-colored bird, evidently accomplishing copulation. Taking place when there were young birds still in the nest, the action aroused conjecture that a second brood was imminent. The male adult seemed to be not only somewhat whiter above, but also very slightly whiter below. When the male flew across the sun or near its direct rays, the large black area on the upper part of the wings showed through from below. With my binocular I was able to distinguish that this was not the small black spot, found on the under wing-coverts.

(7) Arthur Barr reports that *Microtus* seem to be most active in the late afternoon and that is the time of day when the kites feed their offspring. In spite of futile watching during morning hours by both of the authors, we have never observed the adults feeding young between 9 a. m. and 3 p. m. During the middle hours the young hawklet drowses a great deal, crouching with his breast resting on the rough base of the structure. Becoming uncomfortable perhaps at some unevenness of the sticks, he shakes himself free from sleep and changes his posture. At such times he gives a sharp call-note, as if hoping that food may arrive earlier than usual. A considerable portion of the time is spent preening feathers, so that by noon all traces of discoloration from yesterday-afternoon's feast have disappeared and each feather looks surprisingly fresh. [Subsequently I learned that this cleaning-up process is a very lengthy one, beginning late in the afternoon after the last feeding, and continuing on throughout the next day.] At this job the youngster shows proficiency, his preening strokes giving evidence of precision, in strong contrast with the awkwardness of his attempts to balance in the wind. As Arthur Barr has described the feeding operation in detail, I shall add only that there is no doubt that the male rarely takes part in the feeding of the young.

(8) The description of the movements of the adults in and about the nest on May 4 will give a typical picture of kite activities. During the early afternoon a kingbird that had its nest in the same cottonwood tree flew up to the edge of the kites' nest and, perching on a twig that came out from it, looked at the young sleeping kites. About four o'clock I heard the adult kites calling in their plaintive whistle. Shortly afterward the male landed on the perch tree and watched the nest. He had a mouse in his talons and after he had called for some time, the female came to the perch, took the mouse from him

and flew to the nest. She did not land but returned to the perch and landed near the male. After considerable calling the female began to eat the mouse. The male left his perch and flew away holding his wings at a V-shaped angle, fluttering them rather than flapping them. He kept up a continuous calling as he sailed away. He returned in about five minutes with another mouse and the female took that one away from him with a great deal of calling and scolding. This mouse she brought to the nest and began to feed the young birds. Both young sat at the edge of the nest and waited for the female to tear pieces of meat from the mouse. As she dropped her head to the nest, first one and then the other took the offered morsel. Three meadow mice were brought and fed to the young before they refused to eat any more. The female ate the heads and other parts that the young dropped on the nest. After removing pellets and other objects from the nest, she flew away to a nearby tree. Then the male flew to the nest and sat on the edge of it with spread wings and remained there for a long period. The noise from the blind and action within did not disturb him.

(9) Whenever the parents visited the nest with food they always held the mouse grasped firmly in their talons. The talon which held the food was held up against the body and while landing the bird lowered the free foot to grasp the nest. Even parts of mice and insects were carried in this way. At no time did I ever see the birds deliver anything while holding it in their beaks. Even the deliveries to the female by the male in the perch-tree ('lookout-tree') were made in the same way. It seemed to be a regular habit of the female to sit in the perch-tree and call the male to bring food.

(10) For more than three weeks the parent bird followed much the same routine during the feeding operation—first, a dive for a *Microtus*, a flight with it to the lookout-tree two hundred feet from the nest, often accompanied by the mate, then a pause of from ten to thirty minutes for a calm survey of the surroundings, a flight to the nest holding the mouse in its talons, a landing on the broad margin of the structure, a deliberate tearing-off of portions of the corpse and the final feeding of small pieces to the young. Sometimes the food-provider flew straight to the nest. This routine continued until about May 9, when the hawklet was about three and one-half weeks old. On this day, mother White-tail changed her procedure. She passed the *entire* mouse to the hawklet with her talons. Obviously, this was the first time a whole mouse had been offered to the youngster, and yet the mother did not help him dissect it, and he certainly needed help, as my moving pictures clearly prove. It took

him fully one-half hour to discover a method of getting through to the meat. He had had many opportunities of watching her tear the mouse apart by holding the body down with the talons and pulling with the beak, but he did not seem to realize the function of the talons. He did exactly what he had done with the small pieces, namely, attempted to swallow the mouse whole. It was far too large and he succeeded only in gulping the furry creature to the point where the hind legs and tail dangled outside. Choking, he vomited the mouse. Wisely abandoning this futile method, he seized the mouse with his bill and began swinging it about in the air, then dropping it and trying again. For twenty-five minutes he mauled the mouse in this way, sometimes swinging it, sometimes rolling over on to it. Frequently the body slipped away from him, leaving bits of fur sticking to his bill. Finally, by mere chance, when the mouse rolled beneath him, the hawklet happened to put his foot on it and pulled with his beak at the same time. Having once learned the proper method, he quickly acquired efficiency, although Arthur Barr reported late in the same afternoon that the young bird tried to swallow the hind quarters of still another mouse. When he had finished with the first mouse, his feathers were covered with blood and pieces of meat, including his head, breast and all under parts. He was so gorged, that he took a long rest in a crouching position before attempting the cleaning-up job. This he had barely started, when the parent came back with still another mouse, dead as usual. Throughout our observations no other kind of heavy food was offered by the adults, but grasshoppers were rarely brought in. During this first experiment with a whole mouse, the mother bird sat on the lookout-tree and never offered to help.

(11) During the early hours of the day, when the adults were never observed at the nest, the young spent a great deal of their time sleeping. On occasions they would awaken and stretch or stand on the edge of the nest or flap their wings. This was particularly true on May 4, when the young birds were observed from 9.00 a. m. until 5.30 p. m. During this time neither adult returned until about four o'clock in the afternoon. The wind blew hard all day long and, whenever the young started their exercises, I thought that the next gust would cause them to fall out of the nest. While the nest swayed back and forth in the wind, the young would drop down on it and fall asleep.

(12) On May 9, the remaining hawklet was more active and stood up a great deal of the time. It seemed to be hungry and watched the skies for the parent birds. Occasionally it would start calling

when large bird forms passed over the nest. On returning to the blind at four o'clock, I found the young bird still watching the skies and finally one of the adults drifted over the nest and called to the young. It flew around the nest-tree and then over to the lookout-tree. After sitting there for several minutes it flew to the nest and after a close inspection of it carried away a pellet the young bird had regurgitated. This was later in the same day, when the senior author observed the hawklet trying to discover how to dissect a whole mouse, as described previously. The adult female now returned to the nest with a meadow mouse and left it for the youngster. The young bird stood on it and with pulling motions tore it apart. All swallowing actions were accompanied with a pumping motion. The bird would throw its head back and forth with sudden jerks, thus attempting to force the meat down. Each time the head was thrown back the body was lowered and brought to a sudden stop. When the bird regurgitated a pellet it would hold its wings at its side and leaning over with the head held lower than the body, it would go through a series of convulsive reactions before the pellet fell on the nest. On one occasion I saw the bird place its foot on the pellet and pull it away from its face. A long string of fur seemed to be stuck in its throat.

(13) The growth of the feathers in the young was an elaborate process. On April 30, when I was on the oblique ladder within two feet of the nest, the nestlings, then approximately two weeks old, were dark gray on the upper parts, the covering consisting entirely of down-feathers all over the body, including a large part of the wings. The outer secondaries were represented by pin feathers and they were barred with cinnamon and white. These were two inches long in one bird, but shorter in the less-developed one. I examined the open throat carefully at this time and it seemed to be orange-red. On May 9, the remaining hawklet was about three and one-half weeks old and presented a quite different appearance, being covered with dark-brown feathers above, margined by strong buff. The crown was buffy, nape streaked brown and gray, the forehead whitish; the throat and jugulum showed darker buff, almost uniform chestnut, while a blotch of chestnut extended on to the breast. The sides appeared white, slightly spotted with chestnut. On the wings the black patch had begun to form and covered both middle and lesser wing-coverts; the black feathers were margined with white, but the base of each feather was surrounded by gray down. The primaries, now four inches long, were gray. A black line showed between eye and bill along the upper margin of a white loral streak.

The tail, two to three inches long, was very pale gray, distinctly lighter than the darker-gray rump. The entire culmen appeared black, but the edges of both maxilla and mandible were yellow. In addition, there was a white rictal streak. At this time the inside of the throat was plainly blood-red.

(14) The flight of this species may be described as consisting of three different types. First, there is the ordinary motion through the air, consisting of a rather slow beat of the wing, the strokes of which are discernible even when the bird is five hundred feet overhead. When the hawk is driving downward with the wind and soaring, the wings are bent up in the air and give the appearance of an Osprey. Arriving above the lookout-tree, the kite often would throw its wings straight up in the air like those of the Victory of Samothrace and then with the legs dangling, would gradually drop down on to the limb. In the second form, a faster wing stroke is revealed and the general appearance is like that of the Nighthawk. I think this is the maneuver described by Mr. Bent (Bull. U. S. Nat. Mus., no. 167: 60, 1937) as a "pretty fluttering flight with quick wingbeats." These are short and invariably made against a rather strong wind; they seem to vibrate the whole bird. This is not the hovering maneuver, which precedes a stoop, for this one is of longer duration and seems to have no practical function, except that of exercise or play. A few authors have mentioned the third form of flight, the famous "kite" maneuver and some have expressed doubt as to the correctness of the observations. I enjoyed long opportunities watching this performance under the most favorable conditions—good lighting, nearness of the performing birds, and use of a high-powered binocular. In the first place, the performance does not seem to be attempted except when the wind is blowing steadily. It consists of three phases, first an ascent generally by both birds to a moderate altitude, perhaps three hundred feet above the ground. The second is a turning into the wind accompanied by a peculiar fast motion of the wings for about a half-minute, during which the bird seems to make no progress. The wings and body are violently shaken for no obvious purpose; the vibrations of all parts are really tremendous, as if the machine were going to fall apart. Then, as if this were like a purposeful *assonance* in music to make the audience more satisfied with the melodious chord to follow, the bird suddenly resolves itself out of its disorderly gyrations, raises its wings straight into the air and, holding them perfectly still, assumes the appearance of some forms of Japanese kites. I counted the seconds, during which this upraised 'victory' position was maintained. It averaged from five

to fifteen seconds! During this time I did not have to move my binocular to keep the bird in the field of the glass; consequently it is assumed that the hawk made little movement forward or backward. The only other explanation would be that the wind was blowing the kite sidewise either toward or away from me.

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ANIMAL MIGRATION—PERIODIC-RESPONSE THEORY

BY ANGUS M. WOODBURY

THE object of this paper is to review available data pertaining to migration, to reorganize and restate the background material, to present a new theory of migration to be called the periodic-response theory, and to point out ways and means by which the theory can be subjected to scientific experimentation. The writer is indebted to the following for suggestions and criticisms: A. S. Pearse, F. C. Lincoln, Clarence Cottam, May T. Cooke, Walter Cottam, W. W. Newby, William H. Behle, Don M. Rees and others.

It is becoming increasingly clear, as Dixon (1897), Nicholson (1929), Grinnell (1931: 32) and others have indicated, that the migration of animals must be explained upon the basis of natural processes still at work. Migratory movements occur in so many different groups of animals, that the conclusion seems inescapable that the process of migration has arisen independently many times and probably in many ways. There is such wide divergence in the degree of development and methods employed in migration among different groups of animals that it becomes extremely difficult to delimit the concept and define the term. Cahn (1926) considers migration as "a periodic passing from one place to another." Coward (1912: 1) says that "migration is the act of changing an abode or resting place, the wandering or movement from one place to another, but technically the word is applied to the passage or movement of birds, fishes, insects and a few mammals between the localities inhabited at different periods of the year."

The idea of two-way movement is not included in Williams's (1930: 9) concept of migration, which he says "is a periodic, more or less unidirectional continued movement, assisted by the efforts of the animal, and in a direction over which it exerts a control, which results in the animal passing away from its previous daily field of operations." This was obviously designed to include certain insect movements which could not be proved to have a return. It also excluded daily movements, which Cahn included.

The author believes that migration may be considered as periodic passing of animals "from one place to another" in which movements are timed to fit with some periodic rhythm or cycle of the environment, or timed to fit with some stages or steps in the life history of individuals making the migration. This correlation with periodic rhythm implies two-way movement and this in turn implies some

sort of directional control of movements—not merely drifting with the forces of the environment. In some insects, the return movement may be performed by a different generation. Periodic dispersal without return may be considered as 'emigration' in accordance with the definition of Heape (1931).

BIOLOGICAL RHYTHMS

In accordance with this definition, it becomes desirable to take stock of biological activities that are rhythmic or periodic. All activities may for the purposes contemplated here be grouped in a graded series under three headings: non-rhythmic activities, environmentally controlled rhythms, and inherent (hereditary) rhythms. In the first group are those activities that are not correlated with periodic events of the environment, as for example the activities of human growth. In the two other groups are included regularly recurring biological rhythms (cycles) that may be correlated or timed to coincide with such regularly recurring events as day and night, wet and dry periods, tides, the lunar month, annual seasons and longer secular periods. Among these biological rhythms are some that are active as long as the periodic event continues but cease if the event discontinues its periodicity. There are certain snails (Pearse, 1939: 104) having both 'lungs' and gills between which they alternate breathing when living in the intertidal zone at the seashore, but in certain protected estuaries where there is no tide they use gills only. These are examples of the second group. There are many biological rhythms correlated with the periodic events that persist even when removed from the influence of such events. Some persist for short periods, others for longer time and some permanently.

Daily rhythms.—Welsh (1938) in reviewing the field of daily rhythms has shown clearly that many kinds of biological rhythms correlated with day and night persist in the absence of alternating conditions. These changes include such things as biological light production, changes of color, changes in the rods, cones and pigments of the eye, the resting-activity cycle, and other metabolic relations. The mechanisms causing the different cycles may not be the same in all animals but the net response—persistent 24-hour cycles—seems to be similar. The human daily rhythm of activity varies considerably in different latitudes, being strong in the tropics and nearly absent in the polar regions.

In some cases, the phases of a cycle may be experimentally altered, but the tendency to return to normal when opportunity offers seems to be present. Johnson (1940) demonstrated that deer mice (*Pero-*

myscus) kept in continual darkness will continue to exhibit their daily rhythm in which the active period occurs at night, but since they are not necessarily accurate time-keepers, they may gradually get out of phase with actual day and night in absence of the photic stimulation of day. When exposed to continuous light, the active period was postponed slightly on each successive day by increasing the length of the quiescent period. The greater the intensity of the light, the more the active period was retarded. It also tended to break up long active periods into shorter ones. This may be interpreted to mean that light appears to have an inhibiting effect upon the mouse activity, delaying the activity period in continuous light; or in alternate dark and light periods restricting its appearance to the dark. The conclusion seems inescapable that the external stimulus of light in the case reported tended to regulate the rhythmic appearance of the biological cycle.

Despite the fact that daily-movement rhythms are not usually considered as migrations, there is much in common in the general nature of the phenomena and the differences are largely matters of detailed adjustments to different kinds of environmental periodicities. In many cases, the daily movements of animals represent in miniature movements similar to migration, and require similar mechanisms of operation. In lakes and ocean, there are certain daily movements of plankton rising to the surface or sinking into deeper water, that are often called daily migrations.

The daily movements of blackbird flocks (*Agelaius phoeniceus*) may serve as a better example, and may be considered a prototype of the seasonal migratory movements of the same birds. The nocturnal roosting place in cat-tail marshes serves as the home base from which the birds start out in a 'daily migration'. They fly to some distant place with which they may or may not already be acquainted. There may be some mechanism of guidance in either case. After foraging, resting or wandering, a return journey to the swamp must be undertaken. This may be described in almost identical terms with their seasonal migration—a two-way journey from the home base to some distant place and return.

This, of course, is not a definition of migration and it is discussed only for the purpose of showing the inherent similarities of the two patterns, and in a simple way laying a foundation to which more complex patterns may be compared.

Lunar rhythms.—In the intertidal zone on the seashore are many animals with rhythms correlated with the tides which are chiefly influenced by the moon. Certain crabs (Pearse, 1939: 104) can breathe

by means of either gills or 'lungs' and serve as good examples of animals with biological rhythms that depend exclusively upon the external controls for their alternations. If kept constantly in either air or water the biological rhythm initiated by the tides disappears. The periwinkle, *Litorina littorea* (Pearse, 1939: 92) moves up and down the rocky shore as the tide flows and ebbs. Some podurans move up the sandy beach and burrow several inches in the sand when the tide comes in and then emerge after it has ebbed. These are sometimes called tidal migrations.

While the foregoing examples illustrate adjustment to the tidal rhythms as such, some of the animals in the intertidal zone show rhythms which are not only correlated with the tides but also with the daily rhythm. The naked pulmonate snail, *Onchidium floridanum* (Arey and Crozier, 1921: 483) living in protected colonial homes in crevices, emerges for short foraging expeditions during the daytime when the tide is out but is not known to emerge at night. The rhythm disappeared in the laboratory.

Perhaps the most striking lunar responses are found in the marine palolo worms and the grunion fish (Pearse, 1939: 175), in which the responses occur not only correlated with the moon's phases but also with seasons. The Pacific palolo in the southern hemisphere rises to the surface to spawn in great numbers when the moon is full during October and November but the Atlantic palolo in the northern hemisphere picks the time near the moon's last quarter in July. These may be considered as vertical migrations, correlated with moon phase and season.

The grunion rhythm is much more complicated (Thompson, 1919). The small fishes of the species *Leuresthes tenuis* come to the California coast to spawn from March to June each spring. The fish ride the high waves up the beach until they are left stranded. The spawning takes place in the sand near high-tide mark during the nights immediately following the high tides of the full or dark moon. The male is partly wrapped around the female during the act of spawning, during which the eggs are buried in the sand, and are buried deeper by successive lower waves. Two weeks later the eggs are ready for hatching, which cannot take place in the sand. The high tides of the next dark or full moon actually wash out the eggs and release them for hatching. Thus the spawning cycle appears to be correlated not only with season and lunar phase but also with high tides of the full or dark moon that will bury the eggs deeper in the sand and which will be followed by high tides two weeks later that will wash the eggs out of the sand and permit hatching.

Seasonal rhythms.—Woodbury and Hardy (1940) have shown that there is a seasonal cycle of movements in the desert tortoise (*Gopherus agassizii*), in which the tortoises congregate in dens (long horizontal tunnels) in the winter, move out in the spring on to open terrain where they spend the summer, digging short individual burrows when summer gets too hot, and seek the winter dens in the fall. This represents a very primitive type (prototype) of seasonal migration of very limited scope. The seasonal migrations occurring in March and October between the winter dens and summer range, are of very limited distance, usually not over one-quarter mile, but in proportion to mobility and time consumed, the movements of the tortoises may be on a par with the short migrations of some birds. In any event, the behavior patterns are essentially similar in response to season but also have certain problems in common, namely: initiation of movement, determining direction and distance, cessation of movement, initiation of return movements, and so on. Despite these essential resemblances, such movements of tortoises are not generally regarded as migration, but may serve as a type of what may be termed local migration.

Unpublished investigations of the writer have disclosed that some snakes in the temperate mountainous regions of the western United States make similar seasonal local migrations covering somewhat greater distances. Wintering dens have been found containing Great Basin rattlesnakes (*Crotalus v. lutosus*), Western striped racers (*Masticophis t. taeniatus*), and the Great Basin gopher snake (*Pituophis c. deserticola*), which must have concentrated from many square miles surrounding the dens. More than 320 such snakes taken from a single den under conditions which make an estimate of 500 to 1000 snakes a probability, give a basis for estimating that they must migrate up to several miles to spread out over the summer territory and return again in the fall.

Allen (1939: 253) indicates that some bats have similar habits of concentrating in caves for hibernation in the winter and spreading out over the surrounding territory for the summer. The distances traversed in such migrations are much greater than in the snakes, but essentially the same pattern of behavior is presented. The difference in distance traveled is proportionally as much greater than the snakes' as the snake distance is greater than the tortoises'. All three are probably correlated with locomotive ability. Other bats are known to make latitudinal migrations similar to those of birds.

Among the more outstanding biological rhythms correlated with season, in the temperate zone may be mentioned the deciduous habit

among trees, the hibernation and in some cases estivation of cold-blooded animals (also some mammals), the changes of fur and feathers in warm-blooded animals and the ordinary migrations of birds, certain mammals and certain insects. It is, of course, the last type that is of primary interest here but the others are mentioned because they represent phenomena essentially similar in pattern of response to season but employ different methods in effecting the response. The movements of a bird that nests in the temperate or frigid zone and moves toward the equator or to warmer climates to spend the winter and then returns to the breeding area the next season may be considered as typical migration. Consideration of seasonal migration will be deferred for special attention in a later section of this paper.

Some border-line cases may be considered at this point. The activities of certain young spiders and gypsy-moth larvae in spinning long silken threads which they use in 'ballooning' to carry themselves down wind can scarcely be considered as migration. Even though such activities occur regularly correlated with the seasons as typical migrations are, yet there are differences that are significant. In typical migrations, the animals, at least in part, determine their direction and furnish the motive power, whereas in these cases, the spiders and larvae do neither—they are carried and directed by the wind. In true migration, wind at best can only be a favoring circumstance and at worst, can only retard or stop the movement.

Secular rhythms.—Some biological rhythms express themselves periodically in cycles of longer duration than one year. These are not all of the same length and great difficulty has been experienced in finding correlations with or the causes of such cycles. Many attempts have been made to correlate some of them with various phases, fractions or multiples of the sunspot cycle, a full unit of which is believed to take about 45 years, but with at least ten subcycles ranging in length from 8¼ months up to 23 years (Abbot, 1940 lecture), of which the 11-year cycle appears to be more or less primary (De Lury, 1938).

It has been abundantly demonstrated (Clements and Shelford, 1939) that there are secular cyclical fluctuations in population numbers in many animals. Green and Evans (1940) have concluded from their study of fluctuations in the snowshoe-hare populations that with a relatively constant death rate and biotic potential in the adult population, it then depends upon the rate of survival of the young what the trend of the population will be. Since survival of the young depends so much upon competition for food, success of

predators, and other biotic factors, it may be interpreted to mean that the population rhythm of numbers may be so closely correlated with biotic events and so remote from secular periodic events of the physical environment that correlation with the latter in many cases may not be recognizable. Under such conditions, the correlation with biotic events may be more profitably studied.

It is well established that many animals when at peak numbers in the population cycle respond to the population pressure by some kind of movement. Such movement is usually concomitant with hunger and may result in either individual or group activity. In many cases, the movement actually takes the animals away from the home area of their development into new places. Such movements not involving a return journey are sometimes called one-way migrations but a better designation would be secular emigrations. Such emigrations may be either irregularly sporadic or rhythmic, i. e., repeating at more or less regular intervals. An example of the former is the mouse plague of Tulare, California (Hall, 1927) and an example of the latter is the story of the lemmings which has received so much attention in the literature (Heape, 1931: 75). It has been shown, however, that not all animals resort to movement when crowded. The Kaibab deer (Clements and Shelford, 1939: 201) when overconcentrated and starving on their winter range failed to emigrate in search of better places.

Among the insects, secular emigrations appear from time to time in the grasshoppers, dragonflies, moths and butterflies. Some are sporadic and some appear to be rhythmic, but many of them are difficult to classify. Williams (1930) has shown that many moths and butterflies have secular movements which he terms migrations but it seems probable that some examples are only emigrations. At least, a return movement has not been clearly demonstrated, as in the case of *Pieris brassicae* in Europe. In other cases, it seems probable that a two-way migration may exist even though it may not be fully demonstrated. The migrations of the painted-lady butterflies, *Pyrameis cardui* (*Vanessa cardui*) furnish examples. Secular outbreaks occurred in 1879, 1903, and 1926 in which migration flights were reported as common in many parts of the world except South America. Some flights at other times have been reported but they were much less numerous, and tend to emphasize the cyclical nature of the great migrations. It seems probable that peak populations in those years originated in Africa in the spring and spread northward across Europe during the summer. Although there are only slight indications, it also seems probable that there may have been

return migrations in the fall, but the peculiar thing about it is the fact that if so, a different generation performed the return journey. Similar secular migrations have been shown for grasshoppers (Packard, 1880) in which the return migration made by the next generation derived from eggs laid by the migrating individuals occurred in the following year. It should be noted that when these secular migrations develop they are correlated with the proper season of the year in which they occur.

Secular migrations among birds are illustrated in the Snowy Owls which leave their northland habitat in certain winters whenever their lemming food supply becomes too much depleted and return in the spring when other conditions are more favorable.

SEASONAL MIGRATION

Seasonal movement is so common and so important that it will be given special attention. The seasonal rhythm in Nature is so widespread in temperate and frigid regions, that it has produced a large number of responsive biological rhythms. Those that have resulted in migrations have produced some remarkable movements.

In considering responses to seasons, care must be taken to recognize the components of seasonal change: the change in length of the alternating day and night periods, the march of the seasons, the diurnal as well as the seasonal changes in temperature and light, and the wet-dry periods of the tropics. It should be remembered that length of day and night varies from a constant twelve hours of each at the equator through all gradations of intermediates to day and night six months in length at the poles. In addition, it should not be overlooked that the relatively more constant climate of the tropics would not be expected to produce as much rhythmic response as the much less constant climates outside of the tropics. Chapin (1932) quotes Sclater (1905) as estimating that of the 814 African birds, only about 150 showed any migratorial tendencies, and of these, at least half were Eurasian migrants, leaving 71 African species that were wanderers, partial migrants or migrants. This decided contrast with temperate Eurasia or America may be explained as the result of more response to wet and dry periods and not so much to temperature rhythms. Zimmer (1938) has pointed out the fact that south-temperate breeders of South America resemble north-temperate breeders in migration characteristics.

Moisture rhythm migrations.—Spruce (1908) reports that the American Wood Ibis as well as many other waterbirds regularly move between the Orinoco and the Amazon Rivers in South America at such

times as to utilize the stream banks during low water. This is obviously a two-way series of movements correlated with the wet-dry rhythm of the tropics.

Chapin (1932) states that many shorebirds regularly follow the exposed stream-banks in the equatorial regions of Africa shifting back and forth with the fluctuations due to the shifting of the wet-dry cycle. He indicated that there were more sedentary types on lakes with slight variation than on streams with shifting water level but even on the lakes there were more shorebirds when the water was low. The phase was reversed, however, on the Nile River in northern Africa where the birds were more numerous in the flood stage. At that time, the water spread out over the wide flood-plains and made possible the development of a huge food supply that could not appear in the desert without water. Chapin (op. cit.) concludes that "true forest birds are nonmigratory. It is only pronounced seasonal change in weather that causes the birds of the tropical zone to migrate."

In discussing tropical regions, Wetmore (1926: 31) says: "Climatic conditions there are quite uniform, divergence from a level mean being found mainly in the amount of precipitation that marks wet and dry seasons. In careful observation over a limited area certain birds may appear extremely rare for the greater part of a year. Suddenly some forest tree will come into flower or fruit, and immediately these same birds flock, at times in abundance, to feed. They remain common for a period and then disappear."

Seasonal wandering.—There are many examples (U. S. Fish and Wildlife Service files) of birds that show from banding returns a remarkable degree of seasonal wandering without much evidence that the movements follow a consistent directional migration pattern. The returns from Redhead Ducks banded at Bear River Refuge in northern Utah indicate a widespread dispersal in almost every direction where suitable habitat occurs. While such movements are seasonal in nature, there appears to be no correlation with either a directed species movement or a consistently better habitat at different seasons of the year. There is, of course, a return migration to the breeding ground, which constitutes a two-way movement for individual birds and collectively may constitute a two-way migration for the species despite the fact that they seem not to have acquired a consistent directional control.

Food migrations.—The peculiar wanderings of the Red Crossbills have been interpreted by Griscom (1937) as coordinated with food supplies. Being highly specialized for conifer-seed extraction, they seem to be largely dependent upon the conifer seed-crops for suste-

nance. The inconstancy of seed production makes sedentary living in a given spot almost impossible. Apparently then, they have developed a wandering or migratory habit not correlated with seasons but rather, with the occurrence of seed-crops in various localities, which enables them to adjust their movements to the vagaries of seed production. Thus, their movements do not show regular migration rhythms, but do seem to indicate a definite pattern of movements that take them to the areas where and at the time when seeds are available. They are probably in the nature of food migrations correlated with very irregular cycles of food production, which of course, are mainly seasonal or secular.

Altitudinal migration.—Altitudinal migration occurs in many mountainous regions. It is a well-known phenomenon in the mountains of the western United States (Rockies, Wasatch, Sierras) and occurs in the Himalayas in Asia, the Andes of southern South America and possibly elsewhere. The significant thing about altitudinal migration in temperate regions is that it gets temperature effects similar to latitudinal migration in much shorter distance without noticeable change in day length. Chickadees, kinglets, rosy finches and juncos are believed to illustrate this type of migration in the Wasatch Mountains of Utah and the Black and White Redstart in the Himalayas of Asia.

In mountainous regions of the tropics where day length as well as temperature are relatively more uniform, there would theoretically be less expectation of altitudinal migration than in temperate-zone mountains. It is, however, likely that high altitudes within the tropics but at some distance on either side of the equator will show seasonal changes in temperature which may be instrumental in developing altitudinal migration even within the tropics. So far as known, altitudinal migrations are seasonal in character.

Longitudinal migration.—It has recently been established from some of the writer's color-banding operations in Great Salt Lake that young California Gulls reared in rookeries on islands in the lake migrate westward to the Pacific coast in late summer and fall. Records of young gulls banded in June and taken at Seaside near Portland, Oregon, August 3, observed at San Francisco, California, October 25 and 28, and at Monterey, November 15, are quite conclusive evidence that there is, as had been suspected, some longitudinal migration exhibited in this species. The implications of this movement have not yet been studied but it seems clearly evident that young birds leaving the Great Salt Lake in August would find

no significant change in either temperature or day length westward on the Pacific coast.

East-west migrations are, of course, known to occur in other species and at other places. Such migrations across the English Channel (Clarke, 1912) are noteworthy. The Bobolink pursues part of its way (Lincoln, 1939: 161) westward through Wyoming, Utah, and Nevada after coming northward from the Gulf through the Plains States. Files of the U. S. Fish and Wildlife Service show many examples of individual birds making longitudinal migrations, but also show the custom to be fairly common in such species as the American Coot, Purple Finch, and Evening Grosbeak.

Vertical migrations.—Seasonal effects seem much less pronounced upon aquatic animals, but nevertheless, seasonal rhythms do exist. Certain vertical migrations seem to be correlated with changes in surface temperatures of water, due largely to preponderant heat-absorption at the surface in summer and heat-loss in winter or to shifting of surface water by currents. In temperate regions, some animals such as fishes, lobsters, crabs, prawns and squids (Pearse, 1939: 184) living along the shores when surface waters are warmer than underlying waters, descend into deeper waters when surface waters become cooler than those underneath. Similar vertical migrations of pulmonate snails, *Phryganea* larvae and possibly others occur in freshwater lakes where surface water is warmer in summer and cooler in winter than that below.

Anadromous migrations.—Perhaps the most outstanding ocean migrations for purposes of this work are the long-distance migrations of fishes that take them from ocean to freshwater and vice versa across great osmotic barriers. Many freshwater fishes migrate inshore or up small streams to spawn. In the case of anadromous fishes such as salmon, the young fishes hatched in the small freshwater creeks or tributaries at the heads of large rivers make their way slowly downstream more or less independently of the current despite the fact that they are going with it. Eventually, they reach the mouth of the river and enter the ocean without any apparent difficulty with the problem of osmosis. After development in the ocean over a period varying from one to several years, the sexually mature adult individuals make their way back to the mouths of the rivers (may be the same rivers), recross the osmotic gradient and make their way up the stream against the force of the current to the headwaters of the stream where spawning takes place.

While this is a very generalized account, and there are many variations and details not described, nevertheless it illustrates the prob-

lems involved. The spawning, hatching of the eggs, migration down stream and the return migration up stream are all more or less correlated with season. Ir many species, spawning migrations occur every year despite the fact that it may take several years for one individual to become mature. In such cases, there must be a crop maturing each year; otherwise it would be a secular phenomenon coming in occasional years. There are examples of anadromous fishes such as landlocked salmon and brook lampreys, in which the young never reach the ocean and yet are able to propagate and maintain the species.

Catadromous migrations.—In the case of catadromous fishes, such as the Atlantic eels, the process is reversed. The newly hatched conger eels in the deep waters of the Atlantic Ocean between Bermuda and the West Indies make their way slowly over a period of three years toward the North American and European coasts where they also cross the osmotic gradient into freshwater streams. Ascending the rivers, the eels spend from five to twenty years in development before they undertake a return migration. In this case, the eels have to face the current while young and descend with the current as adults in contrast with the salmon. After reaching the ocean, the adults must make a long journey before reaching the spawning deeps between Bermuda and the West Indies.

Latitudinal migrations.—Most important of all are the seasonal migrations that are primarily latitudinal in movement. The seasonal response has had a much larger outlet on land via latitudinal movement than by altitudinal, longitudinal or drouth responses. It is here that the greatest variety of conditions illuminating migration may be found.

The northern hemisphere with its immense area of land in the temperate and frigid zones exposed to great periodicities of the environment should be a fertile field for the development of latitudinal seasonal migration. Because of the immense difference in size of areas in temperate zones of the two hemispheres, it would be an interesting study, if information were available, to compare the number of southern-hemisphere nesting birds that move northward for their winter with the numbers of northern-hemisphere nesters that move southward.

Among the northern-hemisphere migrants, nesting occurs all the way from the tropic line across the temperate zone and beyond the arctic circle as far as land is available. Some of the nesters migrate short distances southward, remaining in the same zone for winter. Others move southward into the tropics, some north of the equator

and some south of it. Still others move into the south-temperate zone and a few others into the antarctic.

Williams (1930) reports a case of the monarch butterfly in latitudinal migration with a behavior pattern somewhat resembling that of birds. According to his evidence, it seems that the newly matured adult butterflies of northern United States and Canada tend to aggregate in flocks in late summer and fall. With approaching cold weather, the flocks migrate southward to suitable wintering grounds of the southern United States stretching from Florida to California, usually south of latitude 31° N., but extending northward up the California coast as far as Monterey and up the Atlantic coast as far as North Carolina. After a more or less inactive period (semi-hibernation) from November to March, the butterflies become active again and begin a return movement (often individually), gradually spreading northward as their milkweed host-plant (*Asclepias*) becomes suitable for egg laying. The young larvae hatching from the eggs develop *in situ* on the milkweed, pupate and complete the cycle by transforming to adult butterflies. This complete migration in one generation resembles that of birds and differs from the other insect migrations already discussed in having both journeys of the migration performed by the same individuals. This is a case in which an obligate vegetarian limited to one scattering host-plant has been able better to utilize the milkweed crop by means of migration. This migration differs from that of birds, however, in that they perform only one migration in a lifetime. There is no learning from experienced individuals. Each generation in turn must find its own way.

Arctic breeding ground.—An area occupied by birds in summer for nesting in the polar regions north of the arctic circle would have almost continuous daylight during the early part of the summer, after which the day length would gradually decrease to twelve hours by late September and finally to continuous darkness by late December. This would be accompanied by a generally equable climate in summer, in which the fluctuations between day and night temperatures would be much less than that expected in temperate climates. The long daylight periods of summer would give the green food-making plants opportunity for long hours of work, resulting in rapid growth of food, part of which would be quickly transformed into insect, rodent or other animal life. Thus the arctic nesting ground furnishes to the bird nesters an equable climate for rearing the young, long hours of daylight in which to tend the young and a rapidly multiplying food supply at the time when the young are growing

vigorously and increasing tremendously the demand on the food supply.

After September, conditions rapidly change—the days grow shorter, the nights get colder, the food supply diminishes, cold-blooded animals hibernate or perish, and much of the area becomes covered with snow. The ideal conditions of summer are almost completely reversed thereafter.

Temperate breeding area and wintering ground.—Nesters of the temperate areas have day lengths in early summer in which to rear the young varying between twelve hours at the edge of the tropics to twenty-four hours at the arctic circle, the length depending upon the latitude. The night temperatures are much cooler than those of the day, differences of 40° F. being not uncommon in some continental areas. The spring-and-summer increase in food supply lasts over a longer period, is more steady and not so meteoric as in the arctic. The nesters spread their breeding periods out from early spring to late summer, some raising more than one brood.

With the approach of winter, snow usually covers the ground in northern areas but its effect usually varies with latitude and altitude, southern portions often being without snow and often without frozen soil. Winter temperatures vary tremendously, being much more moderate in the South. The winter food supply also varies considerably, especially from north to south. Most of the plants are deciduous and become dormant for the winter as do the cold-blooded animals. Warm-blooded birds and mammals are usually the only ones active. Buds, seeds and dried fruits from the plants, eggs, dormant pupae and hibernating adults among the insects and the active rodents are the principal foods available for wintering birds.

Tropical wintering grounds.—Birds of the tropics live under nearly constant temperatures throughout the year. The day and night lengths are nearly equal, not varying much from twelve hours of each, except, of course, as the tropical limits are approached either north or south of the equator, when slight differences become more emphasized. The reproductive cycle in nesting birds functions in regular biological rhythms but seems not to be correlated with any seasonal temperatures, consequently nesting activities are likely to occur at any time of the year whenever the internal rhythm of the bird dictates. They may, however, be correlated with food supply or wet-dry cycles and thus restricted to specific times of the year.

Migratory birds which 'winter' in the tropics are subjected to summer conditions. Since their reproductive cycles do not call for nest-

ing during that period, they are more free to move about than the resident nesting birds with which they may be in competition.

Comparative conditions in moving.—Birds that nested in the arctic or sub-arctic and migrated southward in the fall would leave a region at a time of rapidly shortening days, increasingly colder nights, decreasing daily temperatures, and rapidly depleting food supplies. If they stopped in the north-temperate zone for winter, they would find temperatures somewhat higher but also gradually decreasing both in day and night, day length approximately the same but shortening more slowly, and summer food supplies on the wane but with winter foods still intact.

Other birds that passed them by and went on to the tropics to winter would find little change in day length (late September or early October) but would find relatively constant temperatures considerably higher than those left behind. The tropical food supplies would be relatively constant and available, but migrants would have to compete with resident birds.

Other birds that went from the arctic to the south-temperate zone would find conditions reversed from the north-temperate. It would be like jumping from fall into spring. The day lengths would be increasing; the daily temperatures would be rising both day and night; and the food supplies would be on the upswing after the winter dormancy.

Those birds that went on to the antarctic would find a repetition of conditions of the arctic except that there would not be as much room; the land habitats are much more limited in extent, and there would be no young to rear, consequently no increasing population to expand at the expense of a limited food supply.

Conditions of return.—Birds returning from all these various wintering places where mostly they have avoided winter, must reach the summer arctic and sub-arctic nesting grounds at approximately the same time in order to complete the rearing of the young in the short time available during the summer season. Allowing for considerable variation in the rate of return travel and some variation in time of arrival, there yet remains a considerable degree of parallelism in the times at which the various birds must begin the return journeys.

Those from the antarctic would have to leave at a time when conditions were similar to those prevailing in the arctic when the southward migration was undertaken; namely, rapidly shortening days, declining temperatures both day and night, and depleting food supplies. They would have to cross both the temperate and the tropical regions—a tremendously long journey. Those returning from the

south-temperate and those from the north-temperate zones would be faced with reversed conditions at starting time. The southern birds after spending the summer would be leaving in the southern fall when days were shortening, temperatures lowering and food supplies shifting to the winter condition, whereas the northern birds after spending the winter would be leaving as spring opened, when days were lengthening, temperatures rising, and food supplies flourishing.

Those returning from the tropics would have to initiate their return under conditions relatively similar to those obtaining when they arrived. About the only variable conditions that might need consideration are the periodic fluctuations in the wet and dry cycle, but these vary in time of fluctuation with the latitude and may consequently be considered negligible.

To summarize, all birds leaving the arctic or sub-arctic must initiate migration with inactive gonads under conditions of shortening day length, lowering temperatures and depleting food supplies. After migrating to new areas in temperate, tropical or antarctic regions vastly different from the prospective northern winter conditions which they avoid and spending the winter period under much nearer optimum conditions in other parts of the world, they then must all initiate return migrations at nearly the same time of year under a great variety of environmental conditions in temperate, tropical or antarctic regions. The gonads of many birds may be swelling as a preliminary to later reproductive activity but this may be only a coincidence rather than a causal activity. The great variety of environmental conditions relative to day length, temperature, and food supplies found in antarctic, south-temperate, tropical and north-temperate zones does not stop the return migration and probably has little bearing on its initiation.

PROBLEMS AND THEORIES

Ends served by migration.—Obviously, the chief ends of migration are served by making better use of places or areas that are not equally valuable the year round or that are not equally valuable at all times in their life history. Migration enables mobile populations to shift from one portion of the world to another to take advantage of the opportunities offered. Undoubtedly a greater population density can be maintained by such shifting.

Concomitant with more efficient use of the earth is an obvious advantage from obtaining more favorable, comfortable or optimum conditions of life. Migration leads many birds away from cold

winters and keeps them in almost continuous summer, grasshoppers away from congestion and depleted foods into new areas, and takes salmon or eels from fresh water into sea water or vice versa. This does not imply that they always attain the objective ends, nor that there is any consciousness of the objectives.

Problems of migration.—The principal problem involved in migration is that of providing movement for a population so that areas may be utilized to better advantage of the species than if continuously resident thereon. There may be some exceptions to this general statement, which may be illustrated by landlocked salmon that appear to survive successfully despite the loss of access to the sea. The movement twice a year from place to place and even from one hemisphere to the other is a tremendous task.

The energy involved in migration is enormous. Such an expenditure of energy must be worthwhile to the species. Can it be that migration pays for itself in advantages brought to the migrators? Might the expenditure of energy, for example, in certain juncos, be much more efficiently utilized in migration than in hunting for extra food to maintain the much higher rate of heat radiation from the body in the Far North?

The great orderliness of the migrations seems to indicate that the movements are made with considerable precision and that the great majority of migrants either know the way or are able to find it. The precision indicates that the migrants are somehow oriented in time and finding the way indicates that they are oriented in space.

In moving from place to place, migrants are faced with the problem of geography, especially in relation to feasible routes and avoidance of barriers. The longer the migration the more complex does the problem become. The problem of finding mouths of rivers by eels and salmon, scattered host-plants by monarch butterflies, and Patagonia in southern South America by Golden Plovers seems to present excessively complex enigmas which the migrants must be equipped to solve. Such long journeys, or even shorter travels are bound to take aërial migrants through great varieties of weather and climate. Changing barometric pressures, sunshine, fogs, clouds, high or low humidity, rain, winds, or even hail and snow may be encountered. Changes in temperature are bound to occur and frost or freezing may be part of the lot of migrants, especially if they are delayed in fall or arrive too early in spring.

Both Alexander (1938) and McMillan (1938) suggest that birds make use of wind by utilizing the moving currents of air to help them drift along their way and thus save energy and avoid certain dangers.

Nevertheless, no matter how much they utilize wind in their movements, it seems certain that there must be inherent dangers connected with the air barriers between differing winds and the weather produced by them. The flight speed of birds in calm air would in all probability be maintained by the bird in winds, but the actual distance traversed would be a resultant of the flight speed as modified by the drift of the bird due to the wind. The flight speed is probably greater than the implications of McMillan indicate.

The daily and seasonal periodicities are certain to affect migration travels on land. The problem of whether to travel by day and rest at night or vice versa is one that is solved in different ways by different species. Sometimes it may be necessary to fly long distances without rest as when land birds cross barriers such as the Gulf of Mexico. Arctic birds going to the southern hemisphere have to cross the tropics with season and climate vastly different from that at either end of the journey.

The food supply along migration routes may or may not be greatly different from the usual fare. In some cases, food may actually be unsuitable or unavailable in certain places. Most migrants forestall such possibilities by storage of fat supplies in the body before starting on their journeys.

Many migrants are subject to predation by natural enemies that either follow them or are stationed along the way. Such enemies usually take toll from the passing hosts. It is entirely possible that the weak, the sick and the tired are most likely to be taken by the predators but it is within the realm of possibility that a well-equipped and wary predator such as a Duck Hawk may take almost any individual duck or other bird that it selects from a flock.

There are also physical dangers along the way that may take toll from the moving population. Unfavorable weather conditions, long flights across the ocean, winds from the wrong direction, lighthouses, fogs, storms, and many other conditions hold potential dangers to migrating birds.

From the standpoint of human problems in studying bird migration, Thomson (1926) suggests in addition to his first question of what are the useful ends served by migration, three other problems, namely: what originated and developed the migration custom, what evokes its periodic manifestation in the individual, and how do migrants find their way or what determines the way to be found?

Historical theories.—There have of course been many attempts during human history to explain the riddle of migration. One man after another has contributed thoughts on the subject. These in turn

have been worked and re-worked time after time trying to find an answer. If one may be pardoned for prognosticating, this process will continue indefinitely into the future. Each contribution but serves to make a little larger base for the successive workers in the field.

A review of the principal theories dealing with migration was published by Walter (1908). No attempt will be made here to repeat his work, but certain aspects of older theories must be summarized as background for new interpretations. Little need be said about the ancient Greek and Roman theories of hibernation, transmutation and transportation except to indicate that while they may not have been actually disproved, yet positive proof in support has not been found and they have been gradually relegated to a status of useless or outworn.

Many writers (e. g., Seebohm, 1888; Gätke, 1895; Dixon, 1897; Coward, 1912; and others) have regarded migration as instinctive, but others (e. g., Thomson, 1926: 261) have been more cautious and called it migration impulse, racial custom or some other noncommittal designation. There seems to be, however, an almost unanimity of opinion that there is something hereditary about it. Many writers fail to indicate how it may be transmitted in heredity, others leave it vaguely as an inherited instinct (a cloak of ignorance on the subject), but Cahn (1925: 548) suggests that it may be a "behavior expression of physiological change accompanying gonad activity" which may be inherited. "Everything points to the conclusion that migration is a custom which forms part of the inheritance of the species and which is evoked to repeated activity by periodically recurring stimuli" (Thomson, 1926: 273). There is a whole series of theories based on the idea that external periodically recurring stimuli such as changing length of day, seasonal temperatures, barometric changes, depleting food supply including suitability for nestlings, glacial fluctuations and secular crowding may have been originating causes. None of these is universally applicable to all migrants and consequently they fall of their own weight as causative stimuli although, as will be pointed out later, they may act as regulators. While many writers have considered migration behavior as hereditary, and some have even considered it as induced by physiological conditions, Cahn (loc. cit.) seems to have been the first to point out the possible internal mechanism which might be responsible for its induction.

A few theories are more or less based upon vague generalities or else imply human attributes of intelligence. The premonition theory that animals can forecast coming events to be avoided, the homesick theory that they long to return to the land of their birth, the theory

that animals desire to disperse from their homeland, the theory that birds migrate to find safer nesting sites, and the theory that they move to fill up a vacuum are all in this class. No matter whether the ideas behind these theories have factual basis or not, they are not universally applicable to all migrants. It is difficult to see how any of them could be considered as causative agents. The overpopulation theory is based upon the idea of crowding after reproduction, the surplus being forced away from the crowded area. This assigns a reversed motive from that of the desire-to-disperse theory. It fails, however, to make a satisfactory explanation for the return migration to the area of overcrowding.

Another group of theories is based upon supposed historical considerations that may no longer be operative. Graser's theory (1904) held that birds developed migration in Tertiary times by flying from island to island. The logical implication that birds are becoming less and less migratory today will hardly find approval among present-day zoologists.

The Deichler-Jager northern-home theory and the Dixon-Braun southern-home theory are diametrically opposed to each other in the fundamental assumptions, the one assuming that birds arose from reptiles in the North and spread southward as migration developed, whereas the other holds that birds developed in the South and pushed northward into new breeding grounds as migration grew. The Kobelt-Duncker theory held that there was evidence of both. Glaciation in the ice ages played a large part in the previous ancestral-home theories as well as in independent theories. Wherever used, the ice-age theory is based upon the assumption that birds moved north and south with the fluctuations in the front of the glaciers. A fundamental weakness in this theory is the failure of correlation between migration and glacial movements. They do not operate simultaneously. Migration movements are semi-annual in general, but semi-annual glacial movements are insignificant. Significant movements of glaciers occur in secular cycles (Tarr, 1912).

Mayr (1937) refers specifically to the visual-orientation theory, the retracing theory and the knowledge of geographical position theory of guidance in migration. More recently (1938) both Alexander and McMillan have suggested that wind currents and barriers between them have played an important part in guiding and developing migration routes.

Periodic-response Theory

The author now presents his periodic-response theory of migration. In adding another theory to the imposing list from the past, the

writer is fully aware that it is not a complete answer to the riddle of migration, but hopes that it will lead the way to clearer thinking on the subject and may stimulate others to clarify its deficiencies.

In brief, the periodic-response theory is based upon the following steps: (1) the periodicities of the environment drive animals into rhythmical behavior patterns of movement that tend to be correlated with the periodicity; (2) the development within such animals by independent agencies (mutations) of hereditary behavior patterns which drive the animal to make such movements automatically; (3) natural selection would tend to perpetuate those that were lucky enough to acquire such hereditary behavior patterns; (4) the periodic events would act as regulators and moulders of the hereditary pattern to keep the two in tune; (5) once established, migration routes might be modified in length and direction by other means.

While it seems plausible that those migrations geared to periodicities probably originated in accordance with these steps, it seems necessary to start with step number 2 in order to explain such migrations as those of the eels in which the migrations are in gear with certain stages of the life history instead of with environmental periodicities. In such cases, perhaps the hereditary mechanism would drive the animals out of a more or less uniform environment to a point where periodicities would be encountered.

Nature of migration.—Many writers have contributed ideas useful in the delineation of this theory. Regarding the nature of migration, Coward (1912) quotes Seebohm (1888) that "the desire to migrate is a hereditary impulse, to which the descendants of migratory birds are subject—a force almost, if not quite, as irresistible as the hereditary impulse to breed in the spring." This theme is further elucidated by Dixon (1897: 76), who says ". . . the impulse to migrate is unquestionably instinctive, in the sense of being an hereditary desire transmitted from parent to offspring, which has become so deeply rooted in the uninterrupted course of countless ages to and fro, that in many species nothing but death can eradicate it. Migratory birds if kept in confinement begin to grow restless and unsettled as the usual period of their departure draws nigh; the same irresistible desire is reflected in the gathering of the swallows in autumn; and the unwonted activity of other little feathered voyagers among the trees and hedges may be remarked by anyone who takes the trouble to observe it. This desire to migrate gradually becomes an overwhelming desire, before which all other inclinations bow, and at last, the great flight is commenced."

After citing examples of closely related forms of Song Sparrows,

Horned Larks and Meadowlarks that are partly sedentary and partly migratory, Grinnell (1931) says ". . . the habit of migration is in most kinds of birds a perquisite easily and quickly taken on or put off . . . bird migration is to be dealt with as a subject without any quasi-mystical attributes, one to go at with full confidence that it can be understood . . . upon the basis of facts . . . rationally interpreted." He bases his argument upon four principal ideas, namely, that (1) factors of migration are probably as effective now as ever; (2) the high metabolism of birds making them exceedingly heedful and observant, and (3) the great mobility of birds because of flight allows them to (4) make such population adjustments as may be necessary by means of their own inherent powers.

A working hypothesis is advanced by Wetmore (1926: 29) in which he holds "that migration has arisen from movement induced by seasonal and climatic change developed in certain species until it has become hereditary instinct."

Theoretical basis.—Any adequate theory of migration should be able to offer a plausible explanation for the origin of the custom, its growth and development, its mode of operation and a plausible justification for its existence by means of the ends served. The very making of such a theory implies that it should be open to experimental testing and that the only corroboration can come from evidence to be found in Nature either through observation or experiment. In other words, it must stand or fall upon the basis, not of opinion, but of scientific investigation.

This, then, assumes with Grinnell, that the answer to the riddle of migration must be sought in the realm of natural law and not in mysticism. It is not difficult to find in Nature large series of behavior patterns which grade insensibly from strictly non-migratory into complex migratory types. If it may be assumed that such patterns give the best clues to evolutionary changes, it then follows that the more complex patterns of migration have probably evolved through some such similar steps as are indicated by the simpler behaviors. Some patterns, such as the catadromous migrations of eels, are so complex that there is scarcely any inkling of their origins. Fossil evidence, indicates that birds arose from a group of reptiles which in all probability were non-migratory. Such an assumption, however, should not exclude the possibility that declines in migration may also have occurred.

Establishment of biological rhythm.—Many writers (Pearse, 1939: 169; Welsh, 1938; Johnson, 1939) have called attention to the fact that biological rhythms exist, and that some of them are correlated

with periodic events and some are not. Examples were given earlier in this work. The crux of the matter of origin of migration is to show the plausible establishment of a biological rhythm of movement correlated with a periodic event. Changes in migration after such establishment would be a logical part of the problem of growth and development of routes.

Explanation of the establishment of any biological behavior rhythm involves an interpretation in terms of the laws of heredity. The laws of heredity involve the very foundations of metabolism, especially the activities of the chromosomes in guiding the organization, growth, development and behavior of individual animals as well as the process of maturing and fertilizing germ cells for reproduction. It seems consonant with the laws of heredity to postulate that psychological behavior like physiological activity is concomitant with morphological form, i. e., behavior and activity result from certain types of structure in tissues of a body. Such structures nearly always have considerable leeway of activity. There is generally an optimum and a pessimum which may lie near either maximum or minimum. Morphological structures are recognized as potentially transmissible in heredity in accordance with certain laws.

Hereditary transmission.—Now if a species of animal, bearing any type of non-migratory activity such as may have been transmitted by the reptile forbears to ancient primitive birds (probably similar to certain birds of today), transmits its genetic constitution from generation to generation, the non-migratory activity is bound to be transmitted with it. But such non-migratory behavior undoubtedly would have considerable latitude of adjustment between optimal and pessimal activity. This is well supported by observations and experiments on many species of animals. There are, moreover, great varieties of present-day behavior patterns indicating great departures from the primitive type of pattern and this needs explanation. It brings up the fundamental question of evolution and any explanation of the establishment of the migration custom depends upon the state of knowledge of the fundamentals of biology, especially physiology, genetics, evolution and ecology.

Under the present state of knowledge, three methods of changing heredity between one generation and the next are known. These are: (1) new combinations of hereditary traits normally transmitted by two unlike parents, (2) accidental changes or aberrations in the normal set of chromosomes to make abnormal arrangements which thereafter may be transmitted as normal, and (3) chemical changes or mutations in the genes of the chromosomes which result in some

change in the hereditary traits. The first method is a normal process taking place in every sexual reproduction between two unlike parents. It provides for the continual mixing and rearrangement of the diverse hereditary traits in a breeding population. As a result, the leeway of activity of one individual may be quite different from the leeway of another. A breeding population would therefore present a series of individuals differing slightly from one another and having slightly different optima and pessima. If such a breeding population be exposed over a large area, the environmental conditions encountered by some are bound to be different from those encountered by others. Assume for the sake of example that non-migratory birds once covered the lands of both tropical and temperate zones. Then those of the tropics would encounter relatively uniform conditions and those of the temperate lands would be exposed to varying degrees of periodic changes of the environment.

Adjustments.—In order to explain simply, it becomes necessary to assume that animals had already acquired many characteristics by similar methods to that being elucidated. Cahn (1925: 544) points out that an animal has various regulatory mechanisms that tend to make it respond by appropriate activity to external changes in the environment. He says, ". . . every animal has the capacity to regulate its conditions, but this regulation is limited to the usual fluctuations of its natural and normal environment. When fluctuations pass beyond that point the animal can not adjust to them. Thus an animal regulates through behavior by the following steps: (1) certain processes are going on within the animal; (2) external changes affect the rate of these processes and upset them; (3) the result is movement of the animal in an attempt to adjust to the changes; (4) these movements bring the animal into various conditions, one of which may relieve the disturbance, in which case the disturbing factor being removed, movement would cease, as the equilibrium between processes and environment is established. By these steps we see that the environment of an animal may be regulated by behavior, e. g. movement."

Natural selection.—The temperate-zone animals would be driven to movement to seek adjustment more than those of the tropics. If the extremes of the temperate zone went beyond the pessima of all individuals, they would undoubtedly wipe out the race and the area would be occupied by a race that could meet the conditions. If the extremes went beyond the pessima of only part of the individuals, then there would be chance for natural selection to operate, and in accordance with the Darwinian principle, it could be confidently

expected that there would be a gradual elimination of those whose hereditary limitations could not withstand the extremes and a concentration of those that could. Thus there would tend to be moulded because of the environment a population that could meet the extremes.

But countless ages of such natural selection could probably never bring any additional improvement without the help of methods 2 and 3 of changing heredity between generations. It is the combined effect of aberrations and mutations that allows of the introduction of new or increased abilities for meeting the exigencies of the environment. They make it possible for improvement to occur but they do not assure it. They also make it possible for degeneration to occur but natural selection is likely to prevent survival of such in Nature just as it is likely to insure survival of any improvements.

This implies, then, that continued advancement in adaptation to fit or control environment is probably at the mercy of fortuitous aberrations or mutations. Such is probably the case if judgment can be rendered on the basis of observed phenomena of Nature. The whole graded series of characteristics displayed by organisms seems to suggest that at almost every stage of development some forms have been able to improve and some have not. It seems impossible that beneficial adaptations could come with need. Rather, lucky are those who obtain them and survive because of them, and unfortunate are those who need but do not get and perish for the want. This is a far cry from the philosophy of those who must see a purposive plan in the process of Nature.

Process of adaptation.—The process of establishing biological rhythms in harmony with periodic events in the environment (akin to the origin of migration) seems to involve (1) the exposure of a behavior pattern already developed to the stimuli of periodic events to which it is not yet adapted. This induces the animal to (2) execute movements designed to make itself more optimal or comfortable, thus making an adjustment of the behavior pattern within its hereditary leeway limits. To transform such a voluntary cycle of movement into an hereditary rhythm to be transmitted from generation to generation requires (3) change in the genetic constitution sufficient to make the behavior pattern of succeeding generations automatically respond in a similar way. (4) The appearance of such changes in chromosomes or genes is not necessarily dependent upon the needs of the organism but comes from the exigencies of the hereditary apparatus. (5) Natural selection helps to fix changes in hereditary mechanisms, but cannot of itself initiate such changes.

This outlines a method believed to occur in Nature which not only serves as a method of initiating new behavior patterns but also at the same time serves the additional function of providing a method of successive modifications and improvements. It is only necessary to explain the establishment of a two-way movement rhythm of the migration pattern to account for the origin of migration. Such rhythms may have been initiated many times and in many places. Once established, the course of development can be charted with plausible accuracy.

Independent migration rhythms.—The establishment of a migration rhythm by the method indicated might have been induced by any one or more of the several periodic events of the environment, such as temperature, changing day length, food supply and moisture cycles or possibly by internal rhythms that spur the individual animal into behavior adjustments as Cahn suggested. When such a rhythmical behavior adjustment was transformed into a fixed hereditary cycle, then such a cycle would persist through its own hereditary mechanism independently of the periodic events which might have originally acted as the stimulator to adjustment. Consequently, in searching for the cause of migration, it should not be expected to be found operating upon species with well-developed complex migration, but rather on those species that have incipient migration, those such as Grinnell indicated that are partly migratory and partly non-migratory, that can easily put on or take off the migration perquisite, and those that Lincoln (1939: 84–87) describes with short migrations or partially sedentary habits.

Incipient migration.—In studying incipient migration among birds, care should be exercised in distinguishing between those species that are in process of becoming migratory and those becoming sedentary. Historical perspective based on fossil evidence suggests that the latter type has probably been in a decided minority, because in transforming from the primitive non-migratory reptile-like types to the complex migratory populations of today, there must have been a decided expansion in migratory species.

It may be confidently asserted that precisely the same environmental periodicities that are operative today upon sedentary or incipient migratory species were probably the same periodicities that were operative in the period of migratory origins extending down to the present time. Faced with the periodicity extremes of the temperate zones, various animals have taken different methods of meeting them. Some were doubtless exterminated, many cold-blooded animals hibernated or estivated, some warm-blooded animals developed ways and

means of changing fur or feathers to match extremes, but others developed movement into migration as a method of meeting the changing effects of the periodicities, no matter what kind.

The type of response was undoubtedly geared to the inherent potentialities determined by the hereditary traits as already outlined. The distances covered in migration could not outrun the potentialities of mobility. The development of flight whether of birds, bats or insects made long-distance migration a potentiality but did not assure it. That had to await the combination of the driving forces of the environment with the fortuitous changes of heredity as previously indicated, probably a matter of long-time development.

Gadow (1913: 63) must have had some inkling of this process when he wrote: "What we usually understand by periodic migration cannot have sprung into existence suddenly; it is more like the cumulative effect of the doings of countless generations. The faculty of shifting the abode was of course always there, the necessity of moving further on was also present, and those members of a species which went in the wrong direction came to grief, whilst the others flourished and could return with their progeny. At first, they did not cover great distances, but just enough to find unoccupied ground. The annual repetition became an established habit, at last an ineradicable instinct."

Nichols (1918: 168) suggested that the Red-breasted Nuthatch may point the way to the development of migration. During years of scarcity, there is little or no migration, but at other times, it does show definite migration.

Hereditary control.—As the once-adjustable behavior habits became gradually transformed into hereditary biological rhythms, the animal must have come more and more to depend upon the internal hereditary stimuli to initiate the behavior and less and less upon the periodic stimuli of the environment. This implies that there has been a gradual increase in hereditary control at the expense of environmental control. Such an interpretation seems to be warranted as a corollary of a general interpretation of evolution that each successive step in the increasing complexity of animal organization has been paralleled by an ever-increasing control of and independence from the environment.

When an hereditary migratory rhythm was once established, thereafter the periodic events of the environment would be expected to operate only as regulators or modifiers of the rhythm and no longer as initiators, despite the necessity of considering the whole sequence as a continuing process through the past ages down to the present

and into the future. Such migratory behavior would then depend upon some internal mechanism to initiate the movement in opposite directions at two different times of the cycle.

Environmental regulation.—The question may well be asked, if migration behavior depends upon an internal rhythm, then how does that rhythm keep in tune with the environmental periodicities? The theoretical answer is that the periodic events, as hinted earlier, act as regulators. If the internal rhythm keeps behavior regulated properly, it may never come into conflict with the periodicities, but as Johnson's (1939) study showed with daily periodicities, his mice were not accurate time-keepers and after several months in darkness got out of tune.

May not the same principle apply to other than daily rhythms also? There is good evidence to indicate that this is so. The records of the U. S. Fish and Wildlife Service are replete with examples indicating that the date of earliest return of birds to their breeding territories varies greatly from year to year in some species. The general average seems to vary about one week on each side of the mean, thus giving a period of about two weeks through which dates of earliest arrival usually vary. However, the bulk arrival which is more important to the species probably varies in a similar way.

It seems conceivable, as an explanation, that the earlier arrivals stand in much greater danger of perishing from inclement weather, lack of food or other inherent dangers of the environment than those that come with the mass migration. Nonconformists with the environmental periodicities would under such conditions tend to be culled, thus continually eliminating those in which the hereditary rhythm did not conform.

There is, of course, the alternative explanation that differences in date of return arrival may be due to the regulative action of weather or other factors on the rate of migration. While that may account for the differences in some early-arriving species or in those with poorly developed hereditary rhythms, it will hardly account for species that come late enough so that weather makes little difference or for those with well-developed hereditary rhythms, such as is indicated by the Blue Goose which remains on the Gulf Coast long after the local birds have started breeding activities and then migrates when its own breeding area in the Far North is ready.

There is considerable evidence to show that even in mass migrations, the great bulk of the migrating population may face dangers that produce wholesale slaughter. Roberts (1907) reports a case in which an unusually wet snowstorm in Minnesota struck the main

migration wave of Lapland Longspurs and killed an estimated million birds. A case in which thousands of Eared Grebes were lost in a late southward migration in Utah and Nevada (December 13, 1928) by a similarly tragic snowstorm is reported by Cottam (1929).

An unusually late spring in 1917 with cold rains and snow that prevented normal development of vegetation and insect life in the New England region (Forbush, 1917) resulted in the death of enormous numbers of birds of at least 61 species. Among these, the Purple Martins were almost decimated and seem not to have recovered in that area since (Lincoln, Cottam, Cook, personal communications). Such disasters in spring would leave mainly the later migrants for propagation, which would perhaps tend to retard future migrations in generations descended from them, but this tendency would be reversed by disasters in the fall or winter for southward migrants.

On the other hand, it is conceivable that in other years when the season was earlier than usual, the late-migrating birds might find their insect-food supply so far advanced in its life cycle that food would become scarce before the family rearing was finished and thus act in a similar manner to push the arrival time in the opposite direction—earlier.

Both Alexander (loc. cit.) and McMillan (loc. cit.) have indicated that wind currents may have played an important part in regulating the times of arrival and departure, i. e., birds take advantage of favorable air currents (usually accompanied by favorable weather) in timing their migrations. Their implication is summed up by McMillan (1938: 403): "The bird's arrival and departure dates fluctuate just as the schedule of the winds fluctuates. Spring and the birds came early in 1938. Was one the cause and the other the effect? Why not say both are effects of the same cause—that the influx of tropical air came early this year? The birds migrate and the winds migrate."

His explanation, however, overlooks the larger aspects of the problem. Wind may serve as one of the regulative or culling factors but can hardly be considered as the only one. In all probability, expression of the migration movement is a composite resultant of all the pressures being exerted by all the factors.

Restatement.—The periodic-response theory is based upon the idea that the periodic events of the environment have acted as initiators, moulders and regulators of the migration phenomena by first inducing migratory-habit patterns within the limits of the hereditary mechanism possessed by the animal, then by natural selection perpetuating any hereditary mechanism developed by independent

agencies that tended to transform the habit into an hereditary behavior pattern. The migration behavior thereafter was moulded and guided in its extension, growth and development by the periodic events, which also acted as regulators to keep the hereditary rhythm in tune with them. This means then that the environmental periodicities through their incessant hammering at the biological rhythms have been able to select and guide the development of those animals who were able by independent means to present hereditary mechanisms accompanied by biological behavior rhythms that would coincide with the rhythms of the environment. This may be considered as environmental induction but it is not Lamarckian. It works through independent hereditary mechanisms, the critical thing overlooked by Lamarck. There is, however, another alternative that migratory movements may originate directly from hereditary means.

Origin of migrations.—This periodic-response theory was first announced as the seasonal-response theory by one of the writer's students (Brown, 1938: 141), but further study has convinced the writer that it is of wider application than merely seasonal and that migrations have originated in many places, wherever environmental periodicities have warranted and organisms have been equipped, whether it be on land or in water, in tropical, temperate or frigid zones. In connection with bird migration, it seems reasonable to assume that with the acquisition of flight, birds spread to all habitable portions of the land both north and south of the equator, no matter where they originated, and have since kept the world continuously stocked.

Bird migration, then, may have arisen in almost any place, but the amount of migration expected in any given place would be roughly proportional to the periodic events occurring at that place, conditioned, of course, by the numbers of animals equipped to meet the periodicities and the number that had pushed there in migration from elsewhere. On this expectation, there should be more migrations arising in the temperate and frigid zones than in the tropics and more in the northern hemisphere (on land) than in the southern. Those originating in the temperate or frigid zones of either hemisphere would be based primarily on daylight, temperature, and food rhythms and these might drive the migrants to any distance. With this interpretation, both the southern-home and northern-home theories lose their significance.

Secular applications.—The periodic-response theory has been stated in general terms as a general theory intended to apply to a wide variety of rhythms—daily, lunar, seasonal, secular—but it may need special application in certain cases. Such rhythms may differ considerably

in their expression in the ocean from those on land but they seem to have been effective in both, for migrations appear to be very common phenomena. The daily, lunar and seasonal migrations in the ocean can perhaps be covered satisfactorily by the theory as stated.

The anadromous and catadromous migrations of fishes, however, may call for further elaboration. Most of the marine or lake migrations from shallow to deep water and return or vice versa are seasonal in nature. The freshwater-seawater migrations already discussed are really secular as far as an individual fish is concerned even though the phenomena may be manifested seasonally each year by the species. The secular nature appears to be produced by the sequences of the life-history stages. The periodicity between freshwater and seawater is produced not by the environment itself but by hereditary mechanisms through migrations which take the fish periodically from one into the other. The origin of such migrations is difficult to understand, but it may be that they originated through hereditary mechanisms instead of through adaptable behavior.

The application to secular migrations and emigrations on land is not so clear. There appear to be two possible interpretations of such phenomena. Under one interpretation, population pressure resulting from crowding during a secular peak forces the animals to resort to an ancestral custom now abandoned except in crisis. Under the other interpretation, the animals have an established rhythm of local movement, into which the excess population cannot be accommodated. This forces a break with custom and the resulting movements are erratic and unpredictable. Perhaps there are examples of both.

GROWTH AND DEVELOPMENT OF MIGRATION

Once given established seasonal migrations, no matter how short, then as Brown (1937: 32) says, "it is only necessary to show possibilities of extension and change of direction to account for the migratory routes of today." The environmental conditions found at each end of the route would be important moulding and guiding influences in determining the location of the summer or winter home areas. Each end would be more or less independent of the other and could move about in various ways as needed to fit the exigencies of the situation as it changed from time to time. The route between the two areas would in part be determined by the positions of the ends but conditions along the route might be instrumental in determining its exact location. It seems conceivable that land topography or

water may have a good deal to do with it, but Alexander (loc. cit.) and McMillan (loc. cit.) indicate that both air and water currents may be very important.

Geological effects on migration.—There is good evidence for believing that the geological history is replete with cases that have forced adjustments and changes in routes, and that they have probably been the greatest cause of such modifications. The raising or lowering of land into the ocean, the building of mountains or their erosion, and the ice age are examples of geological phenomena which might change the contour of the land or modify the habitats upon it that migratory animals could use. The ice age, for example, undoubtedly pushed the breeding range of adjacent migratory birds slowly southward as the glaciers advanced and allowed them slowly to expand as the glaciers retreated, thus first gradually shortening the migration route at its northern end and then lengthening it again some thousands of years later. With this interpretation of the effect of glaciers the theory of the ice age as an originating cause may be considered as outworn.

If the West Indies are considered as the remains of partly sunken land, then the migration routes across them from North to South America now involving ocean passage may be considered as the continued persistence of a modified land route. Cooke (1915: 35) regards as a possible explanation of the route across the Gulf of Mexico, that it may be a short cut to Central America gradually transformed from a longer route by land around the west side of the gulf. McMillan considers it a direct use of wind.

Lengthening routes.—These are examples of modification of established routes by means of geological phenomena, but they do not account for the establishment of such routes. Assume for the sake of example that a bird had a short migration route established in the north-temperate zone. How could it be extended to make a long journey beyond the equator and back?

Always contingent upon the bird getting the proper hereditary mechanisms by independent means, then theoretical explanations may be made. If there are advantages by moving south in the temperate zone for winter, would there not be additional advantages by moving farther south? If so, natural selection (other things being equal) would tend to favor those with the longer migration in that direction. Such lengthening of the route would of course be contingent upon favorable conditions of many other factors such as competition, food supply, favorable air currents and so on.

But that would account only for reaching the tropics. How could

routes be lengthened to cross the equatorial regions? Obviously there could be no special advantage from temperature by moving farther south. There may be critical things among other factors which would favor lengthening of the route. Among these, competition for the food supply suggests itself as a possible explanation. If two species using at least in part the same food occupy either the same or adjacent areas in the tropics during their non-breeding residence there, and one is more successful than the other in taking the competitive food, then natural selection would tend to favor those who went beyond the competitive species. By this method, the southern terminus of the migration route might be pushed about almost anywhere within the tropics or even into the south-temperate zone. By the same line of reasoning, migration routes might be shortened or changed in direction by the same process.

An interesting example of lengthening of a route northward is furnished by F. C. Lincoln of the U. S. Fish and Wildlife Service, who reports (personal) that the early records of the Service indicate that the Canvas-backs were not important components of the waterfowl fauna of the Athabasca Delta in northern Alberta in the early years of this century but that the birds have become of major importance within the last few years. The explanation for such a lengthening northward appears to lie in the drying or draining of the marshes of southern Canada and northern United States on which they formerly depended for breeding habitat. It is all the more interesting by comparison with the Redhead which, faced with similar loss of habitat, has failed to extend its migration route in a similar manner.

PERIODIC-RESPONSE MECHANISM

The enunciation of a theory of migration would scarcely be complete without at least suggesting a possible mechanism through which it might work. This is the critical aspect which would provide the basis for experimental or observational testing of the theory. The actual mechanism is so complex and information available so meager that suggestions or hints of the mechanism are about all that can be given. The work of both Rowan and Bissonette has been important in stimulating such studies.

Metabolism.—"It appears manifest that metabolic condition is the crux of the matter," say Clements and Shelford (1939: 216). Metabolic condition is difficult to evaluate. The periodic-response theory involves an hereditary mechanism which automatically motivates metabolism at the critical periods. How this operates is at least

partly a matter of speculation although the speculation may be well based on genetic and metabolic principles.

It is generally agreed that primary control of behavior is vested in the relatively stable nervous system but in the vertebrates at least, primary behavior may be modified by endocrine secretions and may be conditioned by environmental influences.

Nerves and hormones.—The nervous system of an animal is, of course, a product of its hereditary mechanisms, as are also the endocrine glands which provide hormones that modify or condition the nervous control of activity or possibly even initiate certain types of activity.

The control of the hereditary migration rhythm is probably vested somewhere in this nervous-endocrine complex, and it may act in very different ways in different animals such as insects, fishes, birds and mammals. The question of hormone secretion is not very well understood in insects and it seems possible that insect migration may have its control in the central nervous system although such a condition seems doubtful.

In the vertebrates, it seems likely that the control is bound up with cycles between the two—the nervous system and the glandular secretions. It seems almost certain that behavior controlled by the nervous system alone is much more stable than behavior influenced by endocrine secretion which is known in many cases to be fluctuating or cyclical in nature. It may be that endocrine secretion is a means of introducing variable behavior into a more stable type controlled by the nervous system.

Hormones and migration.—Such a point of view may serve as a base for suggesting that migration can be initiated and controlled in the individual by cyclical endocrine secretions which cause the migratory behavior. If so, it is probably independent of the action of the gonads which have been studied so much in this connection. Many young birds migrate before the gonads are completely developed. Migration may be synchronized with fat production. What the secretions are and how, when or where they are liberated is a matter for further investigation and experimentation.

Grinnell (1931) has pointed out that there is probably little difference in the actual amount of wing work and flight between the shorter-migratory Forster's Tern and the longer-migratory Arctic Tern. The difference probably lies in the control that is directed over activity. This is such a complex metabolic matter that it may take long experimental work to elucidate.

Might it be that the secretion governing migration is such that

it initiates action that can only be satisfied by travel, and the quantity of the secretion or the time during which it is secreted determines the duration of flight or the length of the journey? If so, experimental work would first have to determine or isolate the secretion and then test quantitative injections in large numbers of birds to see if length of migration were proportionate to quantity of hormone.

Finding the way.—But even if this theory provides a plausible explanation of the regulation of migratory movement, it still does not explain how migrants find their way or as Thomson (1926: 264) re-phrased it, "What determines the way to be found?"

Some writers have maintained that birds must find their own way by the use of their ordinary senses. Grinnell (1931) indicates in the case of birds that they are exceedingly heedful and observant implying that they can find their way with their ordinary senses without calling upon the aid of a special 'sixth sense.' A similar point of view is revealed by Dixon (1897: 131). "Birds, then, perform their migrations by the aid of extremely acute powers of observation, their inborn aptitude for recognizing landmarks, in other words an intensely receptive memory, the result of experience, a keen knowledge of locality, which civilized man can never hope to realize. But all these wonderful powers would be absolutely at fault on a strange road, so that each individual bird keeps close to a certain route that has been slowly formed during the range expansion of the species." But Dixon (loc. cit.: 76) also indicates that what he calls the migratory instinct is not infallible. "Birds blunder, lose their way and perish in uncounted hosts."

This same theme is amplified by Walter (1908: 266) who says: "Finally, it must be remembered that all who start upon this winged crusade do not reach the holy land. The annual loss of bird life during migration is unquestionably enormous. Birds are not driven by an unfailing instinct that carries them all automatically to their destination. The blunderers and the stupid ones are relentlessly eliminated in countless numbers. The more resourceful ones, the quicker witted, the more vigilant, accomplish the grand tour amid perils innumerable with many a hair-breadth escape and the survivors are those choice spirits who, having thus won their spurs by noble effort, or because they possess the birthright of a superior endowment over their fellows, become the ancestors of other birds. So it is that winning qualities are engrafted upon the race by hereditary transmission. Is it to be greatly wondered at that, after ages of such rigid selection, we should at last have birds today whose performance is so

remarkable that we are tempted to attribute it to powers uncanny and unknown?"

Theories of guidance.—But despite these samples from the many who believe in the natural and non-mysterious explanation of migration, there have been many who invoked occult senses or left it to the operation of unknown instinct. There have also been suggestions of tangible mechanisms for guidance. These include according to Walter (loc. cit.: 262) an unknown magnetic sense, semicircular-canal guidance, a sixth sense of direction, following familiar landmarks, and following leaders who have been over the way before. Mayr (1937) added to these the visual-orientation theory, the retracing theory and knowledge-of-geographical-position theory. Alexander (1938) and McMillan (1938) suggest that birds are guided by air currents and barriers between air currents.

The magnetic theory, although extensively investigated, has found no experimental support. The semicircular canals will help birds keep their gravitational balance but will not help in directional orientation, and even if they did furnish a good explanation for birds, they would not help with insects.

It is to be expected that there will be various grades of development in the ability of animals to guide themselves and determine their whereabouts. Might it not be possible among birds that those with short migrations could get so well acquainted with their range, that the young could become perfectly familiar with the terrain through companionship with those who were already acquainted? And might it not be possible that even longer journeys might be accomplished in the same manner? If so, would such an answer apply equally well to those that had a narrow well-defined route and also to those that advanced in parallel series over a broad front? This implies that many birds use a combination of companionship, familiar landmarks and follow the leader, but might also use air currents and air barriers.

Direction finding.—But will such an explanation hold for birds with longer migrations and more complex routes? Will it apply to insects, fishes, mammals and snakes returning to den? And will it apply to cases in which young birds migrate ahead of their parents (Thomson, 1926: 36) or as in the case of the European Cuckoo migrate much later than their parents? Furthermore, will it apply to birds flying in a dense fog as reported (Walter, 1908: 264) by the Harriman Expedition in which murres flying from their nesting area on Unalaska Island to their feeding grounds on another island sixty miles away, repeatedly caught up with the ship, passed it and went on ahead

out of sight, "flying as steadily and surely as if by compass although it was possible to see hardly more than a boat's length ahead?"

No attempt will be made here to account for the direction finding of salmon, eels or other fishes. Noble and Clausen (1936) have shown that certain kinds of snakes are able to trail one another by smell. This, then, is a mechanism which could theoretically lead young snakes to a den. It is well known that butterflies and moths have keen chemical receptors in the antennae equivalent to smell. Whether they use this sense in migration has probably not been experimentally determined.

Orientation ability.—Rabaud (1928) from the study of many invertebrate as well as vertebrate animals, concluded that animals studied found their ways by means of nervous complexes derived not by summation but by integration from all sensory material. Such ability may be interpreted to consist of more or less subconscious mental organization of all orientation bearings brought in by the senses. It seems reasonable to assume that some animals have an orientation ability much better developed than others. The mayflies, *Heptagenia interpunctata,* studied by Wodsedalek (1911: 270) showed a graded series of phototaxis reactions in experimentation. By adding certain chemicals to the water, they could be changed from negative darkness-hunters to positive light-hunters at different concentrations of the chemicals. There are certainly great differences in the orientation ability of different members of the human race. It is a common experience for many people to be 'turned around,' in which this supposed synthetic orientation ability fails to correspond to actual direction and it is easy then to 'get lost.'

May not birds have a similar synthetic orientation ability which varies not only in different species but also among individuals? If so, would it not account, if exceedingly well developed, for such cases as murres flying in the fog? And if poorly developed, might it not help to account for the great number of accidentals, stragglers and stray birds that are being constantly reported out of their regular range? Some estrays are undoubtedly led over unusual routes by following associated breeding-ground species as in the case of Harris's Sparrow, stragglers of which occur in Utah and Arizona in flocks of Gambel's Sparrows (Woodbury, 1939).

Strange routes.—There still remains the question of young birds migrating over strange paths without the guidance of older birds acquainted with the route. It has been well substantiated (Gross, 1940: 136) that young Herring Gulls exhibit stronger migratory tendencies than do older birds and make longer trips. This probably

applies to other gulls also. In one sense, this is equivalent to the experimental work on the homing ability of birds. In both cases, birds fly over unknown areas, but there is this difference, the homing birds would have familiar landmarks when they neared home; the young migratory birds would be going to a strange country.

The experimental results of homing indicate that the route home is in some cases at least entirely independent of the sensory experiences obtained on the way out, but they also indicate that not all birds can go unerringly back home. Some of them have to hunt, probably at random. Could the success of those that do return directly be related to superdevelopment of the orientation ability?

Could birds going to a strange country without guides be controlled by the inherent migration activators? If a secretion that stimulates flight at a given rate lasts a given length of time, might it not take birds the proper distance and leave them without urge to go further? If this be the proper explanation, will it not also explain the behavior of Rowan's (1926, 1929) juncos which lost their urge to migrate when held until November after their usual time? If so, may not the effect of the stimulating secretion have been frustrated by imprisonment in the cages and the birds left without urge to go when the opportunity offered?

Even if it be the proper explanation, it does not explain the still-open question of why they take the proper direction. Could it be possible that some mental reaction takes place in connection with the orientation ability and in response to sensory perceptions from the environment that determines whether they should avoid or follow ocean shores or rivers, should cross or follow mountains, should fly out over expanses of ocean, or should follow air currents and avoid air barriers?

Experimental investigations.—The problems involved and the questions raised suggest certain types of experimental investigations. One line might well proceed to test the migratory urge in many different species to ascertain its relation to heredity. One method would be to rear young birds or hold old birds under uniform (non-periodic) conditions artificially provided to see if migratory behavior develops in the absence of environmental periodicities. This should theoretically yield a series of patterns grading from those with almost no migration behavior through intermediates to those with very complex migration behavior.

Another method would be to rear young migratory animals in a new location to see what happens to the migratory urge, preferably far removed from the ancestral homes and routes. While this method

has been initiated by the U. S. Fish and Wildlife Service on a small scale, it could well be much extended to include transplantation from one continent to another, always selecting an ecologically equivalent habitat in the new location. Such selections should keep in mind not only the summer home, but also the migration routes and winter home as well. Transplantations might be made from Europe to North America or vice versa and might also include transplantations between the northern and southern hemispheres. The selections would also need careful consideration from the standpoint of economic as well as faunistic impact in the proposed new location. Such studies might well become world-wide in scope and should be fostered by some national or international agency. They would, no doubt, lead to many other problems. The results might have bearing on hereditary mechanisms, effect of environment, finding the way on strange routes and many other aspects.

Another line of investigation might be further pursued in the laboratory. Biochemical differences between migratory and non-migratory closely related animals would present baffling problems, perhaps too great to undertake under the present state of knowledge. It might, however, lie within the practical range of experimental investigation to undertake further studies of the relations of glandular secretions to migration, extending the studies to other secretions beyond those already studied. Such experiments as those of Wolfson (1940) and others might be widely extended.

SUMMARY

There are many biological rhythms which are correlated with periodic events of the environment, daily, lunar, seasonal and secular. Some occur only in response to the environmental periodicities, whereas others are so ingrained in heredity that they persist despite them but may be regulated and kept in tune by the periodicities.

Migrations are forms of rhythms that are correlated with these environmental periodicities, or with stages of the life history of individuals. Seasonal migrations are much more extensive than the daily, lunar or secular, and have become expressed as wandering, moisture-rhythm, altitudinal, vertical, local, food, anadromous, catadromous and latitudinal movements.

The latitudinal migrations are best developed and show the most complex patterns, especially among birds with great powers of flight. Such migrations may be illustrated by two-way movement for example from the arctic to the north-temperate and back, to the tropics and back, to the south-temperate and back, and to the antarctic and back.

The conditions of starting the return are vastly different in each place. Return cannot be explained as the result of periodic fluctuations in day length, temperature or food supply as uniform initiators.

Obviously, the ends served by migration must justify its practice, or it would be discontinued. Migration tends to produce benefits of two kinds: (1) better environmental conditions tending toward comfort and (2) more efficient use of areas at different times. These must offset the dangers to the species, which arise during migration from hostile environment and natural enemies.

As a further step in the integration of theories to account for the origin of migration, the writer suggests in his new periodic-response theory that it has arisen in many animal groups and at various points in time as a response to environmental periodicities which at first were merely conditioned-behavior patterns but which, through mutation and natural selection, have become so fixed in heredity of some animals, that they recur independently of the environmental stimuli because of hereditary mechanisms.

Migratory movements are probably held in tune with the periodic events either by their direct conditioning effect upon behavior or by natural selection for survival of those whose hereditary rhythm automatically keeps them in tune.

When once established, migratory routes may be lengthened, shortened, or direction changed at either end independently of the other by geological agencies such as glaciation or changes in land elevation or by natural-selection agencies such as climate and competition.

A combination of stable nervous system modified by fluctuating glandular secretions probably provides the metabolic mechanism which regulates migration. This is open to experimental investigation by holding animals under artificially regulated environment and by studying the differences between non-migratory, semi-migratory and completely migratory animals.

Migratory animals probably find their way and keep themselves oriented by learning from those already acquainted or by an orientation ability derived by integration of nervous complexes from all available sensory perceptions.

Many questions are left unanswered and it is suggested that certain types of experimental investigations be further developed in seeking for answers. These include field work designed to test animal-migration responses in new locations and under controlled uniform environment, and also include laboratory work designed to discover hormones that may be responsible for initiating or directing migration behavior.

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NESTING OF THE RUDDY DUCK IN IOWA[1]

BY JESSOP B. LOW

Plate 17

INTRODUCTION

THE Ruddy Duck (*Erismatura jamaicensis rubida*), though often elusive and secretive to the hunter and of late years relatively scarce in hunting bags, affords a great deal of pleasure to the Nature lover who seeks the bird in its native haunts. Aside from its esthetic value, a knowledge of the Ruddy Duck's habits during the critical period of reproduction is essential to the conservationist who would wisely perpetuate and increase this game bird. The nesting habits and habitat requirements of the Ruddy Duck were investigated as part of the waterfowl-research program of the Iowa Cooperative Wildlife Research Unit. The results of the research conducted in northwestern Iowa during the 1938, 1939 and 1940 seasons are here presented. Acknowledgments are made to Dr. George O. Hendrickson, Zoology Department, Iowa State College, and to Mr. Thomas G. Scott, U. S. Fish and Wildlife Service, for suggestions and supervision of this work.

An area with an abundance of natural lakes and marshes extending from two to three miles on either side of the Clay and Palo Alto County line was chosen for intensive observations. Within a radius of five miles of the city of Ruthven lie six lakes and numerous marshes constituting the largest single remnant of duck-breeding habitat in Iowa. The lakes, in common with other lakes scattered throughout northern Iowa, are the result of the relatively late Wisconsin glaciation which extended from the north-central part of the State as far south as Des Moines. Glacial débris in the form of morainic hills surrounds the lakes in the southern part but gives way to a high rolling plain in the northern part of the area. Approximately 53 square miles were included although only the 6000 acres of lakes, marshes and sloughs were of particular interest. Lost Island Lake, the largest lake of the group, has a surface area of 1260 acres, while marshy spots as small as a quarter acre are numerous.

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TYPICAL NESTING ENVIRONMENT OF RUDDY DUCK

RUDDY DUCK'S NEST AMONG BURR-REED AND BULRUSH

Water depth varied from a maximum of about twenty feet in Lost Island Lake to several inches in the small marshes, averaging near three to four feet for all areas. According to cover maps used in connection with a study of the Redhead (*Nyroca americana*) over the same period and on the same area (Low, 1940), it was found that only about 1000 acres (16.67 per cent) of the total 6000 acres of water held vegetation dense enough to be favorable nesting habitat for Ruddy Ducks. The amount of vegetation available to nesting ducks appears to bear a close relationship to the prevailing water level during the nesting season and to the extent of vegetation removal by muskrats (*Ondatra zibethica*).

Within the emergent vegetation of the water areas the Ruddy Duck found suitable nesting sites as did the Redhead and occasionally a Canvas-back (*Nyroca valisineria*). Other large birds nesting in the same habitats as the Ruddy Duck were the American Coot (*Fulica americana americana*), Florida Gallinule (*Gallinula chloropus cachinnans*), American Bittern (*Botaurus lentiginosus*), Pied-billed Grebe (*Podilymbus podiceps podiceps*), Eared Grebe (*Colymbus nigricollis californicus*) and marsh-nesting Black-crowned Night Heron (*Nycticorax nycticorax hoactli*).

Few records of the nesting of the Ruddy Duck are found in Iowa ornithological literature prior to 1932. Although there is little doubt that the Ruddy Duck was breeding in Iowa when the earliest settlers arrived, no historical note seems to have been made of it until 1903 when it was reported breeding at Eagle Lake, Hancock County (Anderson, 1907). Its status as a migrant was recorded at an earlier date (Keyes and Williams, 1887). Leopold (1932–33) reported the bird breeding in Palo Alto and Allamakee Counties since 1920; and Bennett (1938) reported on twenty-two Ruddy Duck nests found incidental to his intensive study of the Blue-winged Teal (*Querquedula discors*) during the drought and semi-drought years, 1932 to 1937.

Data were secured by wading or by pushing a small boat through the emergent vegetation of the shallow lakes and marshes. As very few Ruddy Ducks' nests have down-feathers in them and since the female very seldom, if ever, flushes from the nest or nest site—both important clues to the location of Redhead nests—the search involved careful inspection of all the localities that offered nesting possibilities for the Ruddy Duck. A methodical weekly search was made over the nesting habitat of the species to bring under observation new nests and to secure data on those previously found. As a matter of convenience in study, maps of the nesting territory were drawn and the location of each nest was carefully plotted.

NESTING POPULATIONS AND DENSITIES

The first Ruddy Ducks appeared in the Ruthven area on northward migration on March 23 in 1939; however, the birds were first noted on April 14, 1938, and on April 2 in 1940. Warm spring weather, earlier than usual, prevailed over Iowa and surrounding States during the 1939 season when the birds were observed ten days to two weeks ahead of the arrival dates of 1938 and 1940. The principal flights occurred between April 29 and May 6 in the three seasons. It was estimated that 1000 Ruddy Ducks migrated through the area of study each spring, and of these approximately 100 breeding and non-breeding birds remained to spend the season. In the pre-nesting period an unbalanced sex ratio existed in the Ruddy Duck, as well as in the other diving ducks. Of a total 850 birds counted, 497 were males and 353 were females, a ratio of 1.41 males to 1 female. A much higher male-female ratio was found on the nesting grounds of Saskatchewan, Canada, where the average ratio for two seasons was 2.51 males to one female (Furniss, 1935, 1938).

The first nests were built by the females approximately May 8 (46 days after entering the area) in 1938 and 1939, and May 18 in 1940; the peak of nesting occurred June 1 to 15 in all three years. Latest hatching occurred August 13.

Density of nesting varied greatly in the different habitats. On the 1000 acres of potential nesting cover in the region an average of 23 nests, representing an estimated 50 per cent of the total nests, was located each year, or one nest to each 21 acres. However, on exceptionally favored areas the density approached one nest to 10 acres. The maximum nesting density on a 32-acre slough was one nest to 2.4 acres. Redhead nests were approximately twice as numerous as Ruddy Duck nests. Greatest nesting densities were on small, 10- to 15-acre marshes of Dewey's Pasture and in portions of the 1200-acre Barringer's Slough.

PRODUCTIVITY

Fifty-two, or 73 per cent, of the nestings under observation terminated successfully with extremes of 82 per cent in 1939 and 61 per cent in 1940. An average of 69.2 per cent of the eggs hatched. Records from Bear River Marshes, Utah, showed a 38-per cent nesting success and a 52-per cent egg hatch for the Ruddy Duck (Williams and Marshall, 1938). Fate of the nests and eggs during the period of study is summarized in Table 1. Greatest period of hatching was July 1 to 16 during which the eggs in 54 per cent of the nests hatched (Table 2). Nineteen, or 26.7 per cent, of the nests were

unsuccessful. Desertion of nests and eggs, the foremost cause of nest failure, accounted for 17 per cent of all nests (Table 1). Both flooded and deserted nests resulted from extreme variations in the water level. The receding water level of 1940, following a shortage of precipitation, left some nests without water under them and seven of them were deserted. Rapid rises in water levels caused nests to be flooded in 1938 during a rainstorm.

Because the Ruddy Ducks chose to nest in the vegetation above water, predation from terrestrial predators was reduced to a minimum. Within the area of study the common mink (*Mustela vison*) was responsible for two destroyed nests and possibly a third. Eastern Crow (*Corvus brachyrhynchos brachyrhynchos*), a minor predator on Redhead nests, was not known to destroy the nests of the Ruddy Duck. Caution was necessary in deciding the fate of a nest, for eggs in deserted nests were sometimes eaten by predators after desertion.

No more than one undeveloped egg was found in any nest and of 38 eggs left in nests after normal hatching had occurred, eight, or 1.5 per cent, showed no evidence of development. Such undeveloped eggs were distributed throughout the nesting season and could not be correlated with adverse climatic conditions or other factors. Eggs unaccounted for were very few and probably represented those pushed from the nests by females.

Egg laying began soon after the nest site was chosen and a flimsy nest foundation laid. Phillips (1923) noted that the cavity of the nest may be so small as to allow only two or three eggs on one level. Data from the present study indicate that eggs were often piled in a nest in several layers before incubation began. However, once incubation started, the eggs were placed on one level. Often eggs laid over a period of several weeks in an abandoned or destroyed nest were piled in several layers. Incubation commenced after most of the clutch was deposited, but sometimes before the last eggs were laid, with the result that hatching of all the eggs often did not take place at the same time. These late eggs were left in the nests when the females departed with the first-hatched juveniles. Examination of thirty (5.5 per cent) of these deserted eggs showed embryos in which the degree of development varied from several days in some eggs to full-term embryos in others. Some of the embryos were still alive four to five days after the female had abandoned the nest.

The act, often referred to in the literature (Phillips, 1923; Bent, 1923, 1925), of one female laying eggs in another female's nest was observed in this investigation. Ruddy Ducks deposited eggs in other Ruddy Duck nests as well as in Redhead and American Coot nests.

TABLE 1

NEST HISTORY OF RUDDY DUCK IN IOWA

Year	Total nests	Successfully terminated	Unsuccessfully terminated			Total eggs	Eggs per nest	Numbers hatched	Unsuccessful			
			Flooded	Preyed upon	Deserted				Undeveloped eggs	Dead embryos	Eggs in unsuccessful nests	Eggs unaccounted for
1938	21	16 (76.19)	4 (19.05)	1 (4.76)		169	8.1	107 (63.39)	1 (0.56)	19 (11.19)	42 (24.86)	
1939	27	22 (81.50)			5 (18.50)	210	7.4	163 (77.62)	4 (1.90)	7 (3.33)	34 (16.19)	2 (0.96)
1940	23	14 (60.87)		2 (8.69)	7 (30.44)	167	8.8	109 (65.28)	3 (1.79)	4 (2.39)	49 (29.35)	2 (1.19)
Totals	71 (100)	52 (73.24)	4 (5.64)	3 (4.23)	12 (16.90)	546 (100)	8.1	379 (69.42)	8 (1.48)	30 (5.50)	125 (22.86)	4 (0.73)

Again, each of eleven nests (12.6 per cent) of the Ruddy Duck contained from one to four Redhead eggs. The amount of promiscuous egg laying was directly proportional to the amount of unsuccessful nesting during each season of study. None of the parasitic Redhead eggs hatched even though the incubation periods of the Redhead and Ruddy Duck are comparable.

Six Ruddy Duck nests which were under observation prior to incubation and were followed through to hatching, gave an incubation period of 25 days for four clutches, and 26 days for two clutches. Phillips (1923) quotes 21 days as the incubation period, while Bent (1925) says, "Incubation . . . is probably not far from 30 days." The size of the eggs, large for the bird, substantiating the measurements given by Bent, averaged 62.3 by 45.6 millimeters.

The Ruddy Duck, in common with the Redhead and the Canvasback, constructs its nest in the emergent vegetation growing in the water of the marshes and lakes. Often the nest was placed on top of the broken and matted vegetation but more frequently it had a solid foundation of matted material that extended down through the water to the soil. Details of the construction of nests are presented in Table 2. The nests were located at an average of 80 yards out on the marshes, extremes of 0.33 to 250 yards, from the existing high-water mark. One nest hatched even though the water receded from it, but in the main such nests were deserted unless incubation was far advanced. The nest site which the Ruddy Duck chose varied from one yard to 133 yards (average 32 yards) from open water free of emergent vegetation.

The tolerance of the Ruddy Duck for other nesting birds was greater than that of the Redhead. One Ruddy Duck's nest was located in the center of a Black-crowned Night Heron rookery not over a yard from a heron's nest, while another Ruddy Duck availed itself of a Redhead's nest from which a brood had hatched. American Coot nests were appropriated and Bent (1923) states that Western Grebe (*Aechmophorus occidentalis*) nests have been used by the Ruddy Duck.

The water over which the Ruddy Duck nested averaged 13.5 inches deep with a maximum of 36 inches. The depth of the water varied considerably within the nesting habitats during the three years. The choice of nesting sites was governed primarily by the existing water depths, which in turn affected the vegetation. Since the water level fluctuated during the nesting season and varied from year to year, the height of the nest above the mud was taken. An average of 19.8

inches was recorded for the top of the nests above mud, with extremes of 7 and 41.5 inches.

Measurements from one side of the nest to the other ranged from 8 to 16.5 inches and from 4 to 12 inches on the inside of the bowl, averaging 12 inches outside diameter and 7 inches bowl diameter.

The Ruddy Duck constructs a cupola or an overhead protection for the eggs by bending the surrounding vegetation over the nest. Approximately two-thirds of the nests were equipped with cupolas. Apparently for greater ease when entering or leaving the nest, the birds often built runways or ramps of coarse vegetation from the edges of the nests to the water. Twenty-five (35.2 per cent) of the nests had ramps.

The Ruddy Ducks normally built their nests of dead, dry vegetation of the previous year but availed themselves of the green vegetation of the spring to a greater extent than did the Redhead. Some nests were built entirely of green vegetation, but in the average nest 75 per cent of the materials was dead and dry. The vegetation in which the nests were located was rated as dense, medium or sparse depending upon the protection afforded the nest. From 50 to 100 culms of bulrush, 50 to 150 stalks of sedge and 8 to 15 stalks of cat-tail to one-half square meter were considered medium cover; vegetation with fewer stalks to a half square meter was considered sparse; while vegetation with greater numbers of stalks was considered dense. Forty-two (62 per cent) of the nests were located in dense cover, twenty-one (31 per cent) in medium cover, and four (6.0 per cent) in sparse cover.

Nesting Cover Preferences

A cross-section through the favored nesting habitats of the Ruddy Duck in Iowa revealed that the vegetation consisted primarily of lake sedge (*Carex lacustris*) 25 per cent, hard-stem bulrush (*Scirpus acutus*) 10 per cent, and narrow-leaved cat-tail (*Typha angustifolia*) 12 per cent. Slender bulrush (*Scirpus heterochaetus*), awned sedge (*Carex atherodes*), water sedge (*Carex substricta*) and whitetop (*Fluminia festucacea*) were the more important of the minor plants. No nests were located in the reed grass (*Phragmites maximus*), sweet flag (*Acorus Calamus*) or bur-reed (*Sparganium eurycarpum*), which in the aggregate made approximately 15 per cent of the available emergent vegetation; however, these species, as components of the juvenile rearing cover, were of some value. Although vegetation of the nesting cover often occurred in mixed stands, the nests were classified as occurring in the dominant plant species in which each

TABLE 2

DETAILS OF NEST CONSTRUCTION OF RUDDY DUCK IN IOWA

Year	*Top of nest above water (inches)*			*Top of nest above soil (inches)*			*Depth of bowl (inches)*			*Inside nest diameter (inches)*			*Outside nest diameter (inches)*			*Water depth at nest site (inches)*		
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
1938	2.5	8	5.3	7	41.5	26.4	2	5	3	4	8.5	5.9	8	15	11.8	0	36	21.1
1939	3	10	6.7	8	32	16.7	0.5	5	3.1	4	9	7.2	9.5	16.5	12.3	2	26	10.6
1940	4	8	6.1	10	21	16.5	2	5	3.2	6	12	8	10	15	12	1	15	8.5
3-yr. Avg.	3.2	9	6	8	31.5	19.8	1.5	5	3.1	4.7	9.9	7	9.1	15.5	12	1	25.5	13.5

Year	*Distance to open water from nest site (yards)*			*Distance to shore from nest site (yards)*			*Distance from other ducks' nests (yards)*			*Per cent dry nesting material*			*Density of cover at nest site (no. nests)*			*Nests having ramps*	*Nests having cupolas*
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Dense	Medium	Sparse		
1938	.33	200	40.5	0	250	65	20						8 (38.0)	11 (52.0)	2 (9.5)	10 (47.6)	18 (85.7)
1939	1	100	27.7	10	125	64	7				100	74.3	17 (73.91)	6 (26.09)		8 (29.63)	16 (59.26)
1940	2	100	29.5	10	250	116					100	78	17 (73.91)	4 (17.39)	2 (8.70)	7 (30.43)	9 (39.13)
3-yr. Avg.	1.1	133	32.5	6.7	210	81.5	13				100	75	42 (62.68)	21 (31.35)	4 (5.97)	25 (35.21)	43 (66.19)

was located. Table 3 was prepared to show the relative importance of the plant species as regards Ruddy Duck nesting and to show the success and failure of the nests that were placed in the different kinds of plant cover. From the standpoint of total numbers of nests the lake sedge held 21 (40 per cent) nests; hard-stem bulrush was second with 17 (33 per cent) nests; while narrow-leaved cat-tail, third in numbers of nests, was chosen by 10 (19 per cent) of the nesting Ruddy Duck. The data, expressed in density of nests to a cover type, revealed that one nest was constructed to 5.5 acres of the available hard-stem bulrush, one nest to 10 acres of lake sedge, and one nest to 11 acres of narrow-leaved cat-tail. Though limited in area, the 13 acres of slender bulrush held one nest to two acres, and the 12 acres of whitetop held one nest to three acres.

Several factors contributed to the success of the various plant species as nesting cover, including the suitability of the plants for nest construction, the degree to which they decomposed and matted beneath the water, and the availability of the plants to the birds. Since the nesting cover for the Ruddy Duck in Iowa was conditioned not only by the amount of the plant cover but also by the presence of open water, the available amount of each cover species depended upon the existing water level during the nesting period of each year. The presence or absence of nesting vegetation was not substantially affected by water fluctuations over a period of only a month or two, but the selection of a nest site was governed to a large extent by the water depth at the time of nesting. Thus, a shift of the nesting from the hard-stem bulrush in 1938 to the sedges in 1939 and the shift in the same direction in 1940 (Table 3) is correlated with an increase in the water level during the nesting seasons of 1939 and 1940 which rendered the sedges more available and the bulrushes less available than in 1938.

The change in the value of the hard-stem and slender bulrushes from one nest to 8 acres in 1938 to one nest to about 35 acres in 1940 was counterbalanced by a change in the value of sedges from one nest to 75 acres in 1938 to one nest to 15 acres in 1940. These figures, although based upon comparatively small numbers of nests, are sufficiently accurate to indicate a definite change from one cover type to another in direct response to fluctuation of water level.

Thirteen (76 per cent) of the nests in the hard-stem bulrush, seventeen (81 per cent) of the nests in lake sedge and five (50 per cent) of the nests in narrow-leaved cat-tail terminated successfully.

Fresh materials were constantly being added to the nests to compensate for a gradual settling resulting from decomposition of the

TABLE 3

NESTING COVER DATA ON THE RUDDY DUCK IN IOWA

Vegetation in which the nests were located	*Total nests*				*Successful nests*				*Unsuccessful nests*			
	1938	1939	1940	3-Yr. total	1938	1939	1940	3-Yr. total	1938	1939	1940	3-Yr. total
Hard-stem bulrush (*Scirpus acutus*)	12	4	1	17	10	5		13	2	1	1	4
Slender bulrush (*Scirpus heterochaetus*)	1	3	2	6		3	1	4	1		1	2
Lake sedge (*Carex lacustris*)	3	7	11	21	2	7	8	15	1		3	4
Awned sedge (*Carex atherodes*)		3	2	5		3	1	4			1	1
Water sedge (*Carex substricta*)		3	1	4		3		3			1	1
Narrow-leaved cat-tail (*Typha angustifolia*)	3	3	4	10	2	1	2	5	1	2	2	5
Whitetop (*Fluminea festucacea*)		2	2	4		1	2	3		1		1
Reed grass (*Phragmites maximus*)	1			1	1			1				
Sweet flag (*Acorus Calamus*)	1			1	1			1				
Bur-reed (*Sparganium eurycarpum*)		1		1						1		1
Creeping spike-rush (*Eleochris calvis*)		1		1		1		1				
Totals	21	27	23	71	16	22	14	52	5	5	9	19

under part of the nests. Nests well hidden at first were often later exposed because the surrounding vegetation was torn down and incorporated into the nests. During periods of heavy rain, the water level rose several inches, and at such times the ducks were compelled to add materials very quickly to the nests and continue to do so until the water reached the highest level. The capacity to add materials rapidly to the nests when the water level was rising often determined the success or failure of the clutch. The cover species in which the nests were located determined, in part, the ability of the Ruddy Ducks to build the nests sufficiently high to avoid flood waters. During the 1938 season nests constructed of the fine-leaved sedges were almost invariably flooded. The nests located in bulrushes, reed grass, narrow-leaved cat-tail, or other coarse-leaved plants were readily built up high enough, in most instances, to avoid the flood waters. During the 1939 season, when no flooding occurred, little difference was detected in the qualities of the plant species used in nest construction. Vegetation of the previous year provided the nesting cover and materials for slightly over 75 per cent of the nests. Nests built after about June 1 were predominately of green plant materials.

Plant species which decomposed or matted beneath the water during the fall and winter or which shed their leaves leaving only coarse stalks standing had little value as nesting cover. Hard-stem and slender bulrushes stood up well throughout the winter, and yet were pliable enough to be readily used by the nesting ducks. Bulrushes, cat-tails and reed grass were tall enough to be available for nesting even though the water level rose 15 to 18 inches during the nesting season. Sedges, though fine-textured and susceptible to flooding as in 1938, were otherwise excellent nesting cover and nesting materials. Reed grass had little value as nesting cover, while bur-reed and sweet flag were available only late in the season since the old stalks were matted into the water in fall and winter. In contrast to the culms of hard-stem bulrush, the stalks of river bulrush (*Scirpus fluviatilis*) were stiff and tough, and Ruddy Duck nests were not observed in growths of this plant.

Summary

An investigation of the Ruddy Duck in northwestern Iowa during three years (1938, 1939, and 1940) revealed that the most important nesting habitat held stands of hard-stem bulrush and lake sedge occurring either alone or intermixed. The choice of nesting cover was determined not so much by a preference for certain plant species as for a cover type having a desirable water depth. The favored loca-

tion for nest construction was in vegetation growing in 10 to 12 inches of water. A 71 per cent successful egg hatching was recorded for the Ruddy Duck during the study. Predation was negligible because of the selection of nest sites above water.

The most destructive factor to Ruddy Duck nesting was fluctuations in the water level; rapid rises in the water level flooded nests, while the recession of the water level caused nest desertion. Acquisition and stabilization of the water within the nesting habitat appears to determine efficient production of the Ruddy Duck in Iowa marshes.

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ANNUAL CYCLE OF THE BLACK-CAPPED CHICKADEE–2

BY EUGENE P. ODUM

NEST CONSTRUCTION AND EGG LAYING[1]

Cavity excavation.—Most of the nest cavities were freshly excavated by the birds themselves. At least one nest was located in a woodpecker hole and several others appeared not to have been excavated during the current season. As has been already indicated, dead softwood early-successional trees, either well-decayed stubs or limbs, were most frequently selected for excavation. The eighteen nests (eleven 1940 nests plus seven located in 1941) were located as follows: pin cherry (*Prunus pennsylvanica*), four; paper birch (*Betula papyrifera*), three; beech (*Fagus grandifolia*), three; yellow birch (*Betula lutea*), two; willow (*Salix Bebbiana*), two; basswood (*Tilia americana*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), abandoned apple, one each. Mr. E. A. Preble tells me that among dozens of chickadee nests which he has examined in New England many were in stubs of the grey birch (*Betula populoides*), a species largely replaced by the paper birch in the Helderberg region.

The cavities dug by the chickadees themselves were very similar in inside dimensions. The depth (measured from lower edge of entrance hole to the bottom) of seven such cavities varied from 5 to 6.25 inches and the inside diameter at the bottom of the cavity varied only from 2.5 to 2.75 inches. The size of the entrance hole, however, varied considerably and was never completely round like a woodpecker hole. One nest had the entrance in the top as described by Stanwood (1911), but all the others had the entrance in the side. The outside diameter of nesting stubs or limbs varied from 3.5 to 6 inches. The height above ground ranged from one to forty feet, but only three were higher than fifteen feet and eleven were lower than ten feet. There was no particular exposure favored since entrances faced in nearly every direction.

Both sexes take part in nest excavation as has been recorded (Stanwood, 1911; Forbush, 1929). However, the female apparently takes the lead in the selection of the site and in the pair studied most closely she did about two-thirds of the total work. In two cases I happened to be present soon after a cavity was first started. In each case the hole was begun at a point where the bark was broken and the inner soft wood exposed. Also, several times during the

[1] A few 1941 observations have been added to this section to supplement the observations made during the 1940 season.

pre-nesting period birds were observed to be attracted to loose pieces of bark or woodpecker diggings in dead stubs; they would fly down and pick away at such places momentarily. Chickadees apparently may explore about considerably and start several cavities before definitely selecting one as Butts (1931) also reports. Three pairs started cavities only to abandon them for other locations. In this early stage both male and female were observed to try out different places. In pair no. 3 both sexes were observed working at two different points on the same stub at the same time. In still another case the pair worked alternately at two stubs about 100 yards apart, gradually concentrating on one of them. In this case the female definitely led the way back each time to the cavity of final selection.

When the hole is first being started the bird may simply throw the chips over its shoulder, but once the cavity is well under way chips are carried out and dropped a short distance away, often with a flick of the head so that they are scattered somewhat. The bird may then return for another load or its mate may be working in the meantime. The pair do not necessarily take regular turns since one bird may make several successive trips while the other rests nearby. I did not observe one bird digging without the other being near. As in incubation and feeding of the young intermittent behavior characterizes nest excavation. The pair will work for a short while then move off to some other part of the territory to feed and rest. Digging activity was observed at all times of the day, but was most vigorous in the morning. An interesting observation of behavior during cavity excavation is recorded by the following field notes:

7.29–42 a. m. (13 minutes).—Female carried chips out of cavity 23 times and male 14 times. Female largely silent, male frequently whistles and calls softly. Female seems to have the right of way at the nest since the male gets out of the way when both birds happen to fly to the cavity at the same time (indicating female dominance at the nest?). Pair moves west, male going first.

7.42–58 (15 minutes).—Pair feeding quietly 100 yards from the cavity; male feeds female once but she does not beg. Then pair moves back to cavity, female leading.

8.00–05.—Pair back at cavity when a third chickadee appears suddenly. Male pounces on it immediately. All three birds make off to the north, both male and female apparently chasing the intruder.

8.05–08.—Female returns to work on cavity, male still chasing the intruder in distant treetops which apparently mark the north boundary of the territory.

8.10–23 (13 minutes).—Male returns; female makes 14 trips to cavity, male three, then birds move to the south.

8.23–30 (7 minutes).—Feeding quietly several hundred yards from cavity. Pair slowly returns, female leading.

8.30–41 (11 minutes).—Female makes eight trips to cavity carrying out chips each time; male makes three trips, carried no chips on one trip. Pair moves southeast.

8.41–9.27 (46 minutes).—Pair working south and east to extreme boundaries of territory, feeding silently or with soft *seep* calls. Spend ten minutes resting in low bushes. Finally return to cavity, female again leading.

Only four days were required to complete the above cavity, but the time probably varies widely depending on the amount of excavation that has to be done and on the weather. It is interesting to note that in most European Paridae (but not in *P. atricapillus*) the female alone digs the cavity (Steinfatt, 1938).

The nest.—The chickadee's nest consists of a soft wad of plant and animal fibrous material. It really represents a lining for the bottom of the cavity since no coarse supporting material is included. Seven nests were collected after the birds were finished with them and these were examined in detail. All seven contained rabbit hair (from *Sylvilagus floridanus*) and this item formed the bulk of five nests. Horse hair formed the bulk of one nest located in the only territory which included the edge of a barnyard. Soft plant down (from several unidentified plants) and moss were present in all nests. Thin strips of bark and a piece of string turned up in one nest. Thus, while the nest composition varied according to availability, there was a definite preference for hair, moss and other soft materials, which agrees with descriptions of nests in other localities. Two nests studied by Stanwood (1911) in Maine were made of rabbit hair, moss, plant down, and cedar bark. Chapman (1900) speaks of a nest being composed of rabbit fur.

The nests were weighed after they had been kept in the same room for a week or more so that they would presumably have the same relative water content. The weight varied from 1.6 to 10 grams with an average of 4.3 grams.

Apparently only the female carries in nesting material although my observations of the nest-building behavior are limited. In the case of two pairs the male accompanied the female to the nest as she carried a load of nesting material, but remained outside calling and whistling softly as she worked on the nest within. In one of these cases the nest was virtually completed (material may be added during egg laying as indicated below) in two days, the female working at least to some extent both in the morning and in the afternoon. Four loads of material were carried in during thirty-seven minutes of observation in the morning of the first day, and three loads during forty-one minutes in the afternoon of the second day. There then followed a lull of two days before the first egg was laid. In six hours of observation during the daylight portion of these two

days, the pair visited the cavity only four times, the female merely entering and leaving quickly. However, she spent the nights in the cavity. The roosting of the female in the cavity prior to and during egg laying was observed in several other cases also. In these cases the male was observed to accompany the female to the cavity and then to seek a roosting place nearby. One male roosted in the foliage of a small maple about twenty yards from the nest.

Egg laying.—Eggs are laid one a day, before 7 a. m in the case of one female. The first several eggs, at least, are partly or completely covered with nest material by the female after she lays them, as Stanwood (1911) has reported. It may be that fresh material is brought in each day to cover the eggs since I once observed the female carrying in material during the egg-laying period. As the set nears completion the eggs may be left uncovered as is also the case during incubation.

During the egg-laying period the sexes remain closely associated as during cavity construction and nest building. The pair spends most of the time ranging over the territory, feeding and resting. The male may feed the female occasionally and she may beg, although the begging-feeding behavior becomes more pronounced with incubation. One pair was followed for three hours in midday during the egg-laying period without their once going near the nest. The female, however, spends the night in the cavity as during nest building. Apparently little incubation takes place at this time since the eggs in all sets hatched within one or two days. Regular incubation in one case was begun the day before the laying of the last egg.

Chickadee eggs are very thin-shelled. Compared with the House Wren's (*Troglodytes aedon*) egg which can be safely handled, the chickadee egg is so fragile that it can be removed from the nest only with care. Allen (1929) has commented on the thin-shelled nature of the egg. The number of eggs in known sets was as follows:

5 eggs.....1 set (a second brood)
6 eggs.....1 set
7 eggs.....4 sets (one a second nesting attempt)
8 eggs.....1 set
Average: 6.7 eggs per set

Sets of nine or ten eggs have been reported (Forbush, 1929). Seven sets found by Harlow (1918) in Pennsylvania ranged from five to eight, averaging seven. The number of eggs laid by the English *P. atricapillus* ranges from five to thirteen, usually eight to nine (Witherby et al., 1938), while migratory European titmice may average as many as twelve per set (Steinfatt, 1938).

INCUBATION

Rôle of the sexes.—Forbush (1929) states that both birds incubate. Allen (1929) says that in the Black-capped Chickadee the sexes "take turns" incubating. On the other hand Chapman (1900) and Butts (1931) in observing nesting habits "assumed" that the female did the incubating.

A total of 31 hours was spent in observation periods of an hour or more at four different nests during incubation. Also, scattered observations were made on other pairs. In all this there was no evidence that the male takes any part in incubation at any time. While the male regularly comes to the nest to feed the female and was observed once or twice to enter the nest (when the female was absent) he never remained in long enough to do any incubating. It was always the female that entered the nest for the night. As further evidence, the male does not develop a brood patch. During incubation the down-feathers on the breast and sides of the belly of the female are absent and the skin is loose and wrinkled. In the male, on the other hand, the breast and sides of the belly are covered with down-feathers as is normally the case in both sexes during most of the year. Incidentally, the brood patch is a reliable method of sex identification during nesting as is also the behavior outlined below. Only the female *P. atricapillus* in Europe incubates (Witherby et al., 1938).

Just when the brood patch develops was not determined since no birds were caught between April and the beginning of incubation. It persists at least until the young leave the nest and perhaps until the fall molt.

Incubation behavior.—Rhythmic behavior involving attentive and inattentive periods ('on' and 'off' periods) characterizes the activities of the incubating female. While the female is incubating, the male regularly comes to the nest and feeds her. As he approaches the nest he gives a low whistled *phoebe* exactly like the regular song but much softer. Either the two- or three-note version may be given or sometimes only the first note is given. Such a 'signal song' used by the male approaching the nest has been recorded as a regular habit in many passerines; for example, the Song Sparrow (Nice, 1937), Hooded Warbler (Odum, 1931), and Black-throated Green Warbler (Pitelka, 1939). The female may answer the signal song with a low twitter. I cannot say whether she always responds vocally or not since one has to be very close to the nest to hear the twitter at all. Invariably, however, she comes up to the entrance to receive the food.

If the female has been on the nest only a few minutes she usually returns below; however, if she has been on ten or fifteen minutes or more she may leave the cavity either just before or just after receiving the food from the male and fly away for an inattentive period accompanied by the male. Thus, the male plays a rôle in regulating the behavior of the female by providing a stimulus for leaving the nest. However, the male controls the female's movements only within certain limits. If the male does not appear in twenty or thirty minutes the female will leave the nest of her own accord.

As mentioned under courtship, the signal song and the answering twitter may represent a repetition of courtship ritual. Only once was the female observed to whistle softly on approaching the nest; she usually approached the nest silently during both incubation and feeding of young. Chapman (1900), however, records that both sexes gave soft whistles at the nest.

Table 1 summarizes approximately 16 hours of observation of the incubation behavior of three pairs. Observations at a given nest were not made continuously but in one- to three-hour periods at different times of day (early morning, mid-day and late afternoon were times selected) and on different days during the latter half of incubation. The table, therefore, is intended to present a picture of the average inherent behavior (disregarding or 'canceling out' for the moment the variations due to environmental or individual differences) determined by the sample method. From this table we see that the average attentive period was 24 minutes, and average inattentive period 7.8 minutes. The male fed the female at the nest on the average of once each attentive period; about two-thirds of the time he caused the female to leave the nest and begin an inattentive period and about one-third of the time she left of her own accord. The time relations of the behavior of the three pairs were very similar. However, pair no. 15 differed in that the male was not observed to bring food to nest but called to female from a distance, and fed her after she left the nest to join him. Since in all other pairs observed, the male usually brought food directly to the nest, the behavior of the male of pair no. 15 may be atypical. A female Marsh Tit averaged 37.09 minutes on and 7.1 minutes off the nest during an all-day observation (Steinfatt, 1938). The female House Wren (*Troglodytes aedon*), although having about the same body size as the chickadee, averages only about 14 minutes on the nest as compared to 6 off (Baldwin and Kendeigh, 1927). Perhaps the longer attentive period of the titmice is related to the feeding by the male.

TABLE 1

SUMMARY OF INCUBATION BEHAVIOR

Pair No.	*Attentive Period*					*No. of times ♀ leaves nest*		*Inattentive Period*		
	Number recorded	Length in minutes		No. of times ♂ feeds ♀ during one period		When ♂ calls	Of her own accord	Number recorded	Length in minutes	
		Average	Variation	Average	Variation				Average	Variation
7	15	26	15–36	1.6	0–5	11	5	16	5.6	2–10
4	7	23	6–48	1.3	0–8	7	2	9	9.6	3–23
15	7	22	11–61	0.0	—	3	5	8	8.3	7–11
Totals	29	24	6–61	1.0	0–8	21	12	33	7.8	2–23

There did not appear to be a pronounced difference in the rhythmic behavior of the birds at different times of day; that is, the behavior and the length of the off and on periods was about the same in the morning as in the afternoon. However, extreme weather conditions certainly modify the behavior. The longest attentive period, 61 minutes, was recorded during a cold rain; the longest inattentive period, 23 minutes, was during a hot July afternoon.

During the inattentive period, the female keeps up a continual begging (so long as the male is present) giving the *tee-ship* note which is almost identical with the food call of the fledgling. The male feeds the female at intervals and she also feeds herself in the meantime. He may accompany her back to the nest but more frequently she returns alone and very abruptly. While the female is incubating and when not carrying food to the nest, the male moves leisurely about the territory feeding and resting. He may sing occasionally or answer a neighboring male, but compared to many passerine males he expends very little energy singing while the female is incubating.

A vigorously begging female being fed by a male is almost a sure sign of a female with eggs, most likely incubating. If incubating, one need only to follow the female to find the nest, but this is easier said than done since she often returns silently and rapidly and the feeding is not generally done near the nest at this stage.

Some incubating females could be dislodged from the nest only with difficulty. Such birds may puff up and hiss at the intruder (see Forbush, 1929). Other birds, however, flushed immediately when the nest was approached; such females did not give the puffing-up defense reaction.

Incubation period.—The incubation period was determined accurately in only one case, roughly thirteen days. The time between the laying of the last egg and the hatching of that egg was approximately thirteen days and six hours. Forbush (1929) gives the incubation period as 11–13 days. Stanwood (1911) records the incubation period as being twelve days in one case.

CARE OF THE YOUNG

Hatching.—In two cases where hatching was closely observed, the eggs hatched within a period of twelve to twenty-four hours, and they hatched approximately in the order laid. The eggshells were immediately carried away, but I was not fortunate enough to observe whether they were eaten or discarded.

Feeding of young.—The behavior of the adults during the first week or ten days after the young hatch is much the same as during incubation, except that the male, which has been hitherto feeding the female, now feeds the young, while the female brings food to the young when returning from an inattentive period. The female shows the same rhythmic behavior as during incubation; she broods the young for twenty minutes or so and then is off for five or ten minutes. If the male arrives with food while she is on, he passes the food to her at the nest entrance. She may swallow it herself, or I believe she may turn around and pass the food on to the young below. If the female is not on, the male enters and feeds the young. He may remain in as long as two minutes, perhaps looking for excreta. For the first day or so after the eggs hatch the female may continue to beg from the male while she is off the nest. However, only rarely have I seen the male feed the female away from the nest after the young have hatched; instead, he ignores her and feeds the young. Very soon the female stops begging except for an occasional weak effort and both birds devote full energy to caring for their young. The male continues to give his signal song when approaching the nest whether the female is on or not. The female, as a rule, does not announce her arrival. If both birds arrive near the nest at the same time there is mutual wing fluttering. Only twice was a bird seen to enter the cavity when the other was already in.

During the first few days there was usually a noticeable difference in the way in which the sexes approached the nest. The female generally approached more directly and she entered the hole rapidly without pausing on the threshold. The male, on the other hand, usually paused at the entrance, before entering. The early difference in entering technique I interpret as being due to the female's habit of entering rapidly and the male's habit of stopping at the entrance during incubation. As feeding of young progressed, however, this behavior difference tended to disappear and both male and female entered the hole rapidly.

During the final week or so of nest life the adult's behavior is rather different from that of the early period. Brooding stops almost entirely except during cold or wet periods and during the night. Ceremonies are dispensed with as both sexes settle down to supplying the increasing demand for food by the young. The male no longer announces himself by the signal song except occasionally when he may lapse into his old habit in a half-hearted way. Vocal activity in general is quite reduced. The male rarely gives food to

the female at the nest and does not feed her when away from the nest. Wing fluttering may still take place, however. Both sexes now behave nearly alike since the several pronounced differences in behavior have largely disappeared.

Even though there is little brooding, a rhythmic behavior with definite attentive and inattentive periods is still evident in the activity of each parent. Thus, birds tend to feed several times in succession, then be absent for a period, resting or feeding themselves. As already mentioned in the discussion of territory, most of the food is obtained within a short distance of the nest. During inattentive periods, however, the pair may move farther away from the nest, but from my observation they do not cover as large an area (at least not regularly) as during the less strenuous days of incubation. Inattentive periods are often spent in resting quietly and preening. Sometimes the rhythm of the two sexes did not coincide so that one bird might be feeding while the other was off somewhere resting as Butts (1931) also noted. In general, the cooperation between the sexes decreased as the young increased in age.

Observations on the rate of feeding by pair no. 1 were made when the young were one day, four days, eight days and thirteen days old. At the first two ages the male fed two to three times more frequently than the female which spent about two-thirds of the time brooding. At eight days the male still fed about twice as much as female but at 13 days the sexes were feeding about equally and the female did not brood. The total number of feedings per hour by both sexes increased from 6.5 when the young were one day old to 14.4 when they were 13 days old. A similar trend was noted with several other pairs. Butts (1931) found that both sexes share about equally in feeding the young, but his observations were made toward the end of nest life. While the female is brooding regularly, the male apparently feeds the young more frequently than the female.

That feeding six to eight young would put a strain on the energies of the adults can well be imagined, but I did not appreciate the extent of the drain until male birds were brought into the laboratory for physiological measurements. The birds were caught in the late afternoon at the nest, and were kept overnight to be released in the morning, a confinement without food of not more than fourteen hours. Some twenty birds were thus handled during the winter, some kept at low temperatures, with none showing any ill effects on release in the morning. However, the first two males which were feeding advanced young, when given this treatment, were dead in the morning. In subsequent experiments birds were force-

fed at 11 p. m.; these all survived and when released in the morning returned to their nest duties. Thus, the birds worked so hard feeding the young as to deplete their own reserves and reduce their survival time markedly.

During the last week when the young are in the nest the female may not spend the night on the nest; in five observations the female entered the cavity for the night only once when the young were from ten to sixteen days old. Since the young are well feathered at this time and the cavity is well filled by them, it is not surprising that the female might choose to remain outside.

As a rule, chickadees in this area were little perturbed by my presence 15 to 30 yards from the nest and no blind was needed for observation or photographing. Some pairs would not even scold when I examined the contents of their nest. However, as is generally true among birds, the parents seemingly become more concerned about the young as the latter increase in age. In the case of pair no. 1, the birds paid no attention to me when stationed only ten yards from the nest until three days before the young left the nest, when they refused to enter until I retired some fifty yards away.

Length of nest life.—Allen (1929) states that the young remain in the nest twelve days. This is much too short since at twelve days the young are not only unable to fly, but hardly able to climb out of the cavity. In three cases where development was closely watched the young left sixteen days after the day hatching began. If disturbed, the young may leave prematurely. The young of one nest left at fourteen days when the cavity was attacked by a red squirrel; at this age they could not fly more than three or four feet. At sixteen days, however, young made flights extending thirty or forty feet from the nest and were able to keep well off the ground. In order to prevent premature departure it is best to band the young at between nine and twelve days, as later they become excitable.

DEVELOPMENT OF NESTLINGS

Nestlings were removed from the nest from time to time for morphological and physiological measurements. This part of the study will be briefly summarized, leaving the details for a later publication.

External appearance.—The chickadee is an altricial species, hence is hatched in a nearly naked, helpless, blind, cold-blooded state, and with a well-developed mouth and abdomen and, in comparison, poorly developed limbs. Down feathers are located in six small patches, all on the dorsal surface as follows: capital tract, two tufts

(superciliary region); humeral tract, two tufts; and dorsal or spinal tract, two tufts (one each on cervical and dorsal regions). There are only two to twelve feathers in each tuft; one bird had only 29 down feathers in all. There is little or no sign of developing contour feathers or feather tracts in a newly hatched bird, but these appear as dark points in the skin very soon. By the fourth day all the future feather tracts can be made out; the ventral tract generally lags behind the dorsal tracts in development. The 'pin-feather stage' is reached about the ninth day and by twelve days the body is nearly covered with feathers although there are still bare patches on the body and the remiges are partly sheathed. By fifteen or sixteen days the nestlings resemble the adults in plumage except for the short tail, somewhat shorter primaries, and the yellow corners of the mouth.

Weight.—Nestlings weigh slightly over a gram when hatched (average of two broods, 1.13 gms.). When ready to leave the nest they may weigh as much as or even more than their hard-working parents (between 10 and 12 gms.). Increase in weight is rapid during the first nine or ten days with little or no increase between twelve and sixteen days.

Physiological development.—Temperature control begins to develop about the fourth day; that is, muscle tremors (indicating a beginning of a heat-production mechanism) were first detected at that time and the body temperature was maintained slightly above that of the environment at the higher temperatures. Development of temperature control is gradual, but the most rapid changes accompany the period of most rapid growth. However, physiological development is more rapid than feather development. At nine days the heat-production mechanism is well developed but feathers are poorly developed; hence, temperature control is easily broken by a drop in air temperature. By twelve days, feather development has caught up and for all practical purposes the bird is 'warm-blooded' although it does not have the resistance of the adult. The heart rate as well as the breathing rate at average nest temperature (95° F.) is highest at about nine days. This is interpreted as due to strain placed on the circulatory system as a result of lag in feather development (hence poor heat-loss control). Physiological and morphological development of the chickadee, in so far as preliminary measurements show, is very similar to that of the House Wren, which has been studied in greater detail.

Behavior.—The behavior of nestlings closely follows morphological and physiological changes. Nestlings in the cold-blooded stage react

to most stimuli either by opening their mouths for food or by 'squirming'. There is no 'sense of fear' whatsoever. The development of fear coincides with the development of temperature control and the opening of the eyes, which begins at seven days but the eyes are not fully opened until twelve days. By twelve days nestlings may make a hissing sound somewhat similar to the hissing of the incubating female, when the nest is disturbed. Newly hatched birds have a very faint food cry, a very high pitched *eee* which develops into a noisy clatter as they get older. The characteristic begging note (*tee-ship*) is ordinarily not given while the young are in the nest, unless left for sometime without food.

Nestlings of all ages are quite active, moving around in the nest. This activity increases with hunger; when nestlings were removed from nest to laboratory and placed under simulated nest conditions (darkness, proper nest temperature) they remained fairly quiet for the first hour or so but became increasingly restless thereafter. In the nest as the young get larger they become more and more closely packed in the cavity which may be only 2.5 inches in diameter; under such conditions there is apparently a rotation of the young with the hungriest bird tending to struggle to the top of the mass to receive food. Stanwood (1911) observed that the young continually changed positions in the nest. This author also noted that the young excrete immediately after being fed (a gastro-colic reflex common in altricial birds) and that the excreta are taken away immediately, which explains why the excreta rarely remain in the nest long enough to soil it. The excreta were usually carried from the cavity and dropped as the bird alighted, but sometimes were eaten.

Number of broods.—One brood was apparently the rule for chickadees during the 1940 season. However, female R-RB raised successfully two broods, having a different mate for each brood as already explained. It is possible that with an earlier season more second broods might be attempted.[1] There was also one late second nesting following the destruction of the young in the first nest. The nest (pair no. 4) was destroyed on June 10, when the young were less than a week old. On June 14, the pair was observed showing interest in several dead stubs, and eventually they shifted their territory somewhat to the east and dug another cavity (not shown in Text-figure 1) about 300 yards from the first. The seven eggs hatched on July 9 so that the first egg must have been laid about June 20 or 21, ten or eleven days after the first nest was destroyed.

[1] In 1941, when the spring was considerably earlier than in 1940, at least two second broods were successfully completed in the same area.

Steinfatt (1938) reports that among European Paridae, migratory species raise two broods, resident species raise one.

DISPERSAL OF THE YOUNG

Nestlings generally left the nest in the morning although one brood left in the afternoon. I happened to be present when one brood left. The young were very restless prior to leaving, continually coming up to the entrance hole and returning below. Finally, four young left the nest in rapid succession at 9.20 a. m., and the remaining three left in rapid succession at 10.00 a. m. Their first flight was strong even if labored and landed them in bushes twenty to thirty yards from the nest. While the young were leaving the nest both parents flew about excitedly, calling and whistling *phoebe* softly. The parents, therefore, seemed to give vocal encouragement to the young when they left, but did nothing so far as could be seen to coax them out of the nest. After the first group of young left, one parent continued to feed the others in the nest. Very soon after all the birds had left, the whole group began to move south toward the heavy woods (nest was in a small willow bog), in the direction in which the parents usually flew to get food; it seems clear that the young followed in the direction of the parents' movements. By 10.40 the group was in the forest edge and the young were forty feet or more up in the trees. By nightfall the family was at the extreme opposite end of the territory where they all roosted in hemlocks for the night.

A very interesting 'injury feigning' was observed on the day the young left in the case of two different pairs. In each case I captured one of the young whereupon it squealed loudly. Immediately both parents flew at me scolding loudly then perched on a nearby low limb and performed the following antics: wings were held outstretched and slowly flapped back and forth over the back; the head was held straight out and moved slowly from side to side in a grotesque manner. Squeaking on the back of my hand to imitate the cry of the young produced exactly the same result. This 'injury-feigning' behavior seemed to be similar to that encountered in shorebirds and other ground-nesting species except that it did not take place on the ground. Also, apparently, the particular outcry of the young (or imitation of it) is necessary to bring about the behavior since I never observed it when flushing a bird from the nest or while examining nestlings before they left the nest; on these occasions the adults merely scolded vigorously. However, Pettingill (1937) observed 'injury-feigning' in the Acadian Chickadee (*Penthestes hudsonicus littoralis*) when a red squirrel approached the nest.

Five broods of nestlings were banded with colored bands in order to follow their movements and to find out how long they stayed with their parents. One brood was not seen again after they left the nest; the history of the four others is as follows:

Pair no. 16.—Young left nest June 18. June 21, failed to locate family in a search through territory and adjacent areas. June 29, encountered both parents and young at extreme north end of nesting territory (see Text-fig. 1); young begging and being fed by parents, also feeding themselves. July 10, one young moving with a flock of unbanded birds north of the territory; both parents later seen on their territory and not accompanied by any young. July 16, one of marked young in flock with unbanded birds, and the adults of pair no. 15 on the latter's nesting area. Adults have returned to old nest site for second nest.

Pair no. 15.—Young left June 29. June 30, family at extreme south end of territory. July 1, failed to locate birds. August 3, adults in a flock which contained unbanded young birds, one young of pair no. 16, but none of their own young; flock was in center of pair no. 15's old nesting territory.

Pair no. 4 (second nesting attempt).—Young left nest July 23. July 24, still within territory. July 26, could not be found. August 27, one of marked young located in flock with unbanded birds, young and adults of pair no. 17; flock in vicinity of cottage at south end of Lincoln Pond. August 30, marked young again in flock as above; this flock thus contained a pair, marked young from two different nests, and unbanded birds which by their appearance and actions represented young of still other nests.

Pair no. 19 (second brood).—Leave nest August 10. August 15, family together just beyond former territory. August 27, family has been joined by a number of unbanded birds and a banded young from nest of pair no. 4 (see above). August 30, family still together although adults only rarely feed young. September 6, one of young at least with adults in flock. Other young seem to have moved away.

In the literature one finds two opinions regarding dispersal of the young. Many authors have suggested that family ties remain strong and the family group forms the basis for the fall and winter flock. Butts (1931), however, did not find this true, since of two families banded in June, three of the adults but none of the young were present in the vicinity during the winter. Two of the young were later located about a mile away. However, it still remained to be determined exactly how long the young remained with parents.

From the history of the four families outlined above, it seems fairly certain that the young are able to feed themselves independently in about ten days and do not remain with the parents more than three or four weeks. Specifically, young still with parents were observed eleven days and twenty-six days after departure from the nest; conversely, marked young separated from the parents were observed 22, 33, and 34 days after leaving the nest. The young do not necessarily keep together; a few marked individuals were located not very

far from their parents but most of the banded young were not seen again. The large number of unbanded juveniles that appeared on the Preserve in July and August is also evidence of the quick separation and movement of juvenile birds. These can be distinguished with adequate certainty from adults in late summer by their plumage, behavior, and notes. Young birds have fresh clean plumage as compared with worn (particularly the tail) plumage of adults; the young are noisy, fight much among themselves, and their notes are hoarse and immature. The *phoebe* song is given frequently but is often imperfect and readily distinguishable from the song of the adult which is infrequently heard in late summer.

The first flock that was not a family group, was observed on July 10. It was composed of one marked and four unmarked juveniles. All of the subsequent flocks that were observed during the rest of the summer contained predominantly young birds, although as the adults finished nesting duties they would join the flocks of young. As observations given above indicate, the late-summer flocks were composed of adults and young from as many as three or four different nests. Consequently, it seems fairly certain that family groups do not start the flock behavior, but that the young themselves (with perhaps non-breeding birds) form loose flocks and wander about extensively. The adults, for the time being at least, remain on or fairly near their former nesting territory (but not near the nest) and join such birds as appear in the area.

NESTING MORTALITY

Adults.—From the ten nesting pairs watched most closely, three adults were lost; two females disappeared and one male was accidentally killed. The male (of pair no. 16) was replaced by male of pair no. 6 (to form pair no. 19) whose mate was one of the two females lost; neither of the latter was replaced, so far as known, so that the result was the breaking up of two nests. Mortality from natural causes was two out of twenty birds or 10 per cent. The fact that the birds had difficulty in replacing lost mates indicated that there were few if any unmated birds in the region after May 1.

Nestlings.—Of the ten nests shown in Text-fig. 1, six or 60 per cent were successful, four were unsuccessful. Two were abandoned because of loss of females and two (pairs no. 4 and 7) were destroyed by predators after the young had hatched. In the latter cases, the predator reached into the cavity through the entrance and pulled out the contents. Hair found near one cavity indicated that a raccoon may have been the culprit in this case. Pair no. 4 nested success-

fully a second time although the nest was attacked by a red squirrel with loss of one young. Pair no. 7 did not re-nest as far as was known. To sum up, out of eleven sets known to be laid (representing all nesting attempts) comprising approximately 74 eggs (the exact size of two sets was not known), a total of 53 nestlings was fledged. Nesting success figured in this manner comes to approximately 70 per cent.

Nice (1937) has summarized data on nesting success. The average of successful nests was 46 per cent for passerines having open nests and 65 per cent for hole-nesting passerines. The percentage of eggs from which young were fledged averaged 43 per cent in six studies involving mostly open-nesting species. Compared with this, from 61 to 76 per cent of eggs laid by titmice (in nesting boxes) in Holland were successfully fledged (see Nice, 1934). These figures indicate that hole-nesting as compared with open-nesting passerines have a high percentage of nesting success. The 60 per cent nesting success and 70 per cent egg success of chickadees on the Huyck Preserve in 1940, accordingly, is comparable to the averages found in other studies involving hole-nesting passerines of temperate regions of Europe and North America.

Regarding the increase in population, the twenty birds present at the beginning of the breeding season produced 53 young or a percentage increase of 265. This might be compared with the average of a fourteen-years' study of the House Wren, *Troglodytes aëdon* (Kendeigh, 1937), where the average number of adults nesting on fifteen acres was 19.7 and the number of young produced was 56 or a percentage increase of 284. Since at least three adults were lost, the net increase in chickadee population was 17 adults plus 53 fledglings or 60 birds as compared with 20 present at the beginning of the season—a three-fold increase between April and August.

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INHERITANCE OF WHITE PLUMAGE IN *PHASIANUS*

BY J. H. BRUCKNER

Plate 18

THE data herewith presented deal with the inheritance of white plumage in the Ring-necked Pheasant, *Phasianus colchicus torquatus*. In a previous publication (1939) the author has pointed out the scarcity of knowledge concerning the genetics of this species and reported on the inheritance of an incompletely dominant, autosomal gene for melanin. A general review of the literature on the genetics of the pheasant is given in that paper and accordingly will not be repeated here.

The pheasant fancier has long had blue-eyed white pheasants in his aviary, but the origin of this variety is apparently unknown. Occasionally reports are publicized of pure-white pheasants being shot in the wild. Whether such birds result from mutations occurring in the wild population or have escaped from aviaries cannot be proven, but the latter alternative seems unlikely.

White plumage among wild species which are normally colored is not uncommon and albinos have been reported in many birds as well as in mammals, reptiles, amphibians, etc. In very few birds, however, is the exact nature of the white determined and in many cases the specimen described is not a true albino at all but merely a bird with more or less depigmentation of the plumage. In the bird with complete albinism melanin is absent in all parts of the body. The eye appears pink in color because of the blood in the capillaries of the iris and retina. In most white birds the eye is black, brown, orange, or bluish, and all of these colors indicate the presence of melanin. True albinism is rare but birds in which a colored eye is associated with white plumage are common.

During the past nine years, approximately a million pheasant chicks have been hatched at the New York State game farms and among these but one true albino has been found. It is not uncommon to find white chicks, but usually these have some pigmented down on the wings. Almost without exception such chicks develop some pigmented feathers as they assume the juvenal and adult plumages and 'pied' birds, not white ones, are the final result.

Inheritance of color in the Domestic Fowl. a species in the same subfamily as *P. colchicus,* may give some indication of what might

be expected of color in the pheasant. In that species white plumage may be due to any one of three different genes. The White Leghorn fowl carries a unifactorial, incompletely dominant, autosomal gene which inhibits the formation of melanic pigment. Fundamentally the White Leghorn is a colored bird, but the presence of the inhibiting gene in homozygous form prevents the expression of black. In heterozygous individuals some color is evident. This type of white plumage is found occasionally in other breeds, but so far as is known is the result of crossing with White Leghorns.

The second kind of white plumage is that found in Plymouth Rocks, Wyandottes, Dorkings, Langshans, and other breeds of fowl. This white is autosomal and recessive and is apparently due to the absence of a gene necessary for the formation of melanin. Since the eyes are pigmented in both the dominant and the recessive whites, neither is a true albinism and both should be considered as a kind of white in which the manifestation of melanin is usually restricted to the eye. Bateson and Punnett (1908) described another 'complementary' white in Silkie fowls, but no other workers have been able to detect it in that breed.

True albinism is so rare in the fowl that in the thirty-nine years since the rediscovery of Mendel's laws only one case has thus far been reported. The condition was found by Warren (1933) to be a simple autosomal recessive character.

The white pheasant shows no signs of pigmentation in the plumage, but beak and shanks are a pearl white and the eyes are blue. It can be seen that the white plumage of the pheasant might possibly be any one of the genetically different types of white reported above, or possibly still another, since in these white pheasants the eye is blue, a condition not found in any of the white fowls mentioned above. Moreover, the shank color is affected in white pheasants but not in most white fowls. It is possible, of course, that in these white pheasants the shank- and eye-color dilution are due to other genes closely linked with that for white plumage.

In the absence of definite information of the genetic basis for white plumage in the pheasant an investigation was begun in 1938. While it was under way another report of 'hereditary albinism' was found. Taibell (1928) concluded that white is a monohybrid recessive character. He called his white specimens 'albinos', but the description furnished indicated that they were blue-eyed whites. Since his studies were somewhat limited, it seems advisable to report the present experiments.

GENETIC ANALYSIS

The first crosses were made in 1938. A male and two female white pheasants were purchased from a fancier with the assurance that they had bred true for many generations. These birds had white plumage, blue eyes, and pearl-white beak and legs. There were no colored feathers anywhere in the birds nor did they show any after the adult molt.

The male was mated with four Ring-neck females and the two white females were mated to a Ring-neck male with the following results:

Parents	*Progeny*	
	Number	*Color*
White ♂ × Ring-neck ♀ ♀	89	Ring-neck
Ring-neck ♂ × white ♀ ♀	14	Ring-neck

This is what would be expected in the F_1 generation if the white plumage were due to a recessive, unifactorial, autosomal gene.

If the character were sex-linked and recessive, that would be shown by differences in the progeny from reciprocal matings. The mating of normal, colored, Ring-neck males to white females would then produce F_1 progeny with normal plumage, but in the reciprocal mating of white males to Ring-neck females, the female progeny would be white, while the male progeny would be Ring-neck color. Since such 'criss-cross' inheritance was not found, these first matings demonstrated the autosomal nature of the gene.

At maturity most of the F_1 birds were identical in appearance with the Ring-neck stock, but an occasional bird exhibited a completely white primary or tail-feather. Others had a patch of white feathers on the throat but in the majority white was not in evidence. All progeny had dark-pigmented eyes, beak and shanks.

F_2 GENERATION

In 1939, the F_1 progeny of the white ♂ × Ring-neck ♀ ♀ were mated *inter se* to produce the F_2 generation (pen 1-39). This was also done for the progeny of the Ring-neck ♂ × white ♀ ♀ (pen 2-39). In these F_2 generations the expectation was 3 colored : 1 white, if the white were a simple, recessive character. Classifications at hatching, including embryos dying late in which color could be determined, were as follows:

	Hatched		*Late dead embryos*		*Combined*	
	Ring-neck	White	Ring-neck	White	Ring-neck	White
Pen 1–39	70	25	25	6	95	31
Pen 2–39	44	13	10	4	54	17
			Combined total		149	48
			Expected (3 : 1 ratio)		147.75	49.25

Taken either separately or together these matings yield an unusually close fit to the 3 : 1 ratio expected. About one hundred of these birds were reared to maturity and in none of them did any of the white segregates assume the Ring-neck plumage or show the pied condition.

It was noted that a number of these (adult) birds had an occasional dark feather, particularly on the head. Conversely, some of the F_2 Ring-necks had an occasional white feather in the wing or a small white patch of feathers on the throat. Doubtless these were individuals heterozygous for white. Birds of that genotype must have comprised two-thirds of the F_2 population, but since only a few of the Ring-necks showed any white feathers, it is clear that the white plumage is usually completely recessive in the heterozygote.

The symbol *c*, which is used to denote the gene for recessive white in the fowl, is assigned to this gene responsible for the absence of color in the pheasant. The normal wild Ring-necked Pheasant would thus be *CC*, while the pure-white birds would be *cc*.

BACKCROSSES

The expectation here, as in any backcross to the recessive form, was a ratio of 1 colored : 1 white. Backcross matings of F_1 progeny were made to the white male and females. One of the original white hens died during the breeding season and, accordingly, two additional white hens were obtained from the original source of the stock used in the experiment. The results were as follows:

	Hatched		*Late dead embryos*		*Combined*	
	Ring-neck	White	Ring-neck	White	Ring-neck	White
Pen 3-39	33	21	21	15	54	36
Pen 4-39	61	66	30	15	91	81
			Combined total		145	117
			Expected (1 : 1 ratio)		131	131

There is a deficiency of white chicks in both these backcrosses. Application of the χ^2 test for goodness of fit of observed and expected ratios (in combined totals) yields a value for χ^2 of 2.992 and, with $n = 1$, the value for p is .083. This means that the deviation from expectation is not significant, and, therefore, the hypothesis that a single gene causes the recessive white is not invalidated. Dunn (1923) reported a lethal gene linked with recessive white in White Wyandotte fowl. The deficiency of whites in these pheasant backcrosses does suggest that embryonic mortality is higher in *cc* embryos than in *Cc* ones. However, there was no deficiency of the homozygous recessives in the F_2 generation and the discrepancies in the backcrosses should therefore be ascribed to chance. Since the deficiency of whites was evident in the embryos dying late, any lethal effect of the white in the homozygous condition must have been exerted in embryos dying at some stage before the plumage color could be determined. It is noticeable that the major deviation from the expected 1 : 1 ratio was in pen 3-39, which yielded a ratio of 54 Ring-neck to 36 white chicks, whereas pen 4-39 gave a ratio of 91 Ring-neck to 81 white chicks. The latter is a reasonably good fit to the normal ratio.

Some of the white birds from the backcrosses showed an occasional dark feather and a few of the Ring-necks showed a white feather or two as was the case in the F_2 matings.

F_3

In order to check further the conclusion as to the genetic basis for white plumage, the white segregates from the backcross matings, pens 3-39 and 4-39, were mated *inter se* in 1940. Two such matings were made with the result that 75 chicks were hatched. These chicks were all pure white when hatched, and at maturity showed no signs of colored plumage.

DISCUSSION

The source of the white pheasants as bred in captivity is not definitely known, but, as has been mentioned, white individuals in wild birds of other species are not uncommon. Some of these wild specimens are true albinos, but they are relatively rare. Game breeders differ in their opinions as to the origin of this variety. Some believe it to be a true mutation or 'sport' while others think that it is the result of selection from 'pied' or 'spotted' stock. This latter aberrant form is relatively common. Correspondence with observant game breeders has indicated that white mutations from Ring-neck and melanistic pheasants have been known to occur.

It is evident from the data presented in this paper that white plumage in the pheasant, *Phasianus colchicus*, is due to the presence in the homozygous condition of a unifactorial, autosomal gene. Dominance of the allele, *C*, for color, is sometimes incomplete since heterozygous individuals often show occasional white feathers. Conversely, homozygous recessive individuals may show a slight ticking or a colored feather. Recessive white segregates from backcross matings breed true when mated *inter se*.

It would seem that white plumage in *P. colchicus* is similar in character to the recessive white found in White Wyandotte, White Plymouth Rocks and other varieties of fowls. However, in the pheasant the pigment in the eye, beak and shank is so reduced that these structures appear bluish, whereas these areas are not affected in white fowls. This suggests that the genes responsible for white plumage in the two species are not comparable or else, possibly, that the pheasant carries a gene, or genes, for the dilution of eye, shank and beak color closely linked with the gene *c* responsible for absence of color in the plumage. However, since in all the white birds raised in this study no exceptions were observed to the rule that white pheasants have blue eyes, beak and shanks, it seems most probable that the single gene, *c*, is responsible for the dilution of melanin pigment in these areas as well as for its elimination from the feathers.

SUMMARY

White plumage in the genus *Phasianus* is due to a single, autosomal, recessive gene, *c*, present in the homozygous condition. This is shown by ratios observed in 103 F_1, 262 backcross, and 197 F_2 pheasants following crosses involving white and Ring-neck Pheasants.

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EXPLANATION OF PLATE 18

UPPER FIGURE: Normal Ring-necked Pheasant, *Phasianus colchicus*, used in study of the inheritance of white plumage. F_1 hybrids between this bird and pure-white pheasants cannot be distinguished from the common Ring-neck except in rare instances where one or two main tail- or wing-feathers may be white.

LOWER FIGURE: Pure-white pheasant used in this study. The white segregates in the F_2 and backcross matings are identical in appearance and breeding behavior with the original white stock.

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NORMALLY PLUMAGED RING-NECKED PHEASANT

PURE-WHITE RING-NECKED PHEASANT USED IN THIS STUDY

DISTRIBUTION OF THE FAMILIES OF BIRDS

BY ALBERT A. BARDEN, JR.

THE division of the world into six faunal regions by Alfred Russel Wallace (1876) is familiar to most zoölogists. Wallace used chiefly the distribution of mammals in arriving at the extent and boundaries of his regions but he was greatly indebted to the British ornithologist, Philip Lutley Sclater, for the latter had announced in 1858 a division of the globe into six regions based on his study of the distribution of birds. Sclater had proposed the following regions: Palaearctic, Ethiopian, Indian, Australian, Neotropical and Nearctic; and they were adopted almost exactly by Wallace with the exception of a change of name of the Indian region to Oriental as being more descriptive. Other zoögeographic divisions of the world have been advanced but Wallace's is undoubtedly the best known.

Mayr (1935) has estimated that there are approximately 27,000 named species and subspecies of birds known today, a great increase over the number known to Sclater and Wallace. Continued study of their relationships has resulted in the creation of many new families while other groups, which once enjoyed the family rank, have been consolidated. The most recent work of this type is Wetmore's 'A Systematic Classification for the Birds of the World' (1934). In this classification, 166 families of Recent birds were recognized and it has been followed closely in this paper, the sole change being a consolidation of the families Loriidae and Psittacidae made necessary by an unfortunate confusion existing in the nomenclature of these two groups. This of course reduced the number of families to be considered here to 165. Mr. Rudyerd Boulton of the Field Museum suggested to me that it would be a worthwhile project to map the distribution of each of the families of birds according to Wetmore's classification and then to classify each family as belonging to one or more of Wallace's regions. This I did, basing the maps mainly on data from Peters's 'Check-list of Birds of the World', Knowlton and Ridgway's 'Birds of the World' and Stresemann's 'Aves' in Kükenthal's 'Handbuch der Zoologie'. When the maps had been completed, an attempt was made to form a table showing the distribution of all the families of birds among Wallace's regions. However, it soon became apparent that certain families could not be placed fairly in any of the regions as defined by Wallace so they were omitted from the table. The families thus eliminated were as follows: Spheniscidae (penguins), Diomedeidae (albatrosses),

Procellariidae (shearwaters and fulmars), Hydrobatidae (storm petrels), Pelecanoididae (diving petrels), Phaëthontidae (tropic-birds), Fregatidae (frigate-birds), Chionidae (sheath-bills) and Stercorariidae (skuas and jaegers). These are all waterbirds and most of them nest on islands and range widely over the oceans between breeding seasons.

Several other families were also eliminated because they are limited to oceanic islands, which do not fit well into Wallace's scheme. The families thus removed were as follows: Apterygidae (kiwis) and Xenicidae (New Zealand wrens) of New Zealand; Mesoenatidae (roatelos, monias), Leptosomatidae (cuckoo-rollers and ground-rollers), Philepittidae (asities), Hypositтidae (coral-billed nuthatches) and Vangidae (vanga shrikes) of Madagascar; Rhynochetidae (kagus) of New Caledonia; Raphidae (dodos, solitaires) of the Mascarene Islands; Todidae (todies) and Dulidae (palm-chats) of the West Indies; Drepanididae (Hawaiian honey-creepers) of the Hawaiian Islands.

The elimination of the 21 families noted above left 144 families to be considered and their distribution is shown in Table 1.

NOTE: X denotes presence of family in region; x denotes presence of family in region but not a typical member.

TABLE 1

DISTRIBUTION OF FAMILIES OF BIRDS AMONG WALLACE'S REGIONS

Family	*Region*					
	Palaearctic	*Ethiopian*	*Oriental*	*Australian*	*Neotropical*	*Nearctic*
Struthionidae, ostriches	x	X				
Rheidae, rheas					X	
Casuariidae, cassowaries				X		
Dromiceiidae, emus				X		
Tinamidae, tinamous					X	
Gaviidae, loons	X					X
Colymbidae, grebes	X	X	X	X	X	X
Pelecanidae, pelicans	X	X	X	X	X	X
Sulidae, gannets	X	X	X	X	X	X
Phalacrocoracidae, cormorants	X	X	X	X	X	X
Anhingidae, snake-birds	x	X	X	X	X	X
Ardeidae, herons, bitterns	X	X	X	X	X	X
Cochleariidae, boat-billed herons					X	
Balaenicipitidae, whale-headed storks		X				
Scopidae, hammerheads		X				
Ciconiidae, storks, jabirus	X	X	X	X	X	x

TABLE 1—(*Continued*)

Family	*Region*					
	Palaearctic	*Ethiopian*	*Oriental*	*Australian*	*Neotropical*	*Nearctic*
Threskiornithidae, ibises, spoonbills	X	X	X	X	X	X
Phoenicopteridae, flamingos	X	X	X		X	x
Anhimidae, screamers					X	
Anatidae, ducks, geese, swans	X	X	X	X	X	X
Cathartidae, New World vultures					X	X
Sagittariidae, secretary-birds		X				
Accipitridae, hawks, Old World vultures, harriers, ospreys	X	X	X	X	X	X
Falconidae, falcons, caracaras	X	X	X	X	X	X
Megapodiidae, megapodes			X	X		
Cracidae, curassows, guans, chachalacas					X	
Tetraonidae, grouse	X					X
Phasianidae, quails, pheasants, peacocks	X	X	X	X	X	X
Numididae, guinea-fowl		X				
Meleagrididae, turkeys					X	X
Opisthocomidae, hoatzins					X	
Turnicidae, bustard-quails	X	X	X	X		
Pedionomidae, collared hemipodes				X		
Gruidae, cranes	X	X	X	X		X
Aramidae, limpkins					X	x
Psophiidae, trumpeters					X	
Rallidae, rails, coots, gallinules	X	X	X	X	X	X
Heliornithidae, sun-grebes		X	X		X	
Eurypygidae, sun-bitterns					X	
Cariamidae, cariamas					X	
Otididae, bustards	X	X	X	X		
Jacanidae, jacanas		X	X	X	X	x
Rostratulidae, painted snipe	x	X	X	X	X	
Haematopodidae, oyster-catchers	X	X	X	X	X	X
Charadriidae, plovers, turnstones, surf-birds	X	X	X	X	X	X
Scolopacidae, snipe, woodcock, sandpipers	X	X	X	X	X	X
Recurvirostridae, avocets, stilts	X	X	X	X	X	X
Phalaropodidae, phalaropes	X					X
Dromadidae, crab-plovers		X	X			
Burhinidae, thick-knees	X	X	X	X	X	
Glareolidae, pratincoles, coursers	X	X	X	X		
Thinocoridae, seed-snipe					X	
Laridae, gulls, terns	X	X	X	X	X	X
Rynchopidae, skimmers		X	X		X	X
Alcidae, auks, auklets, murres	X					X
Pteroclidae, sand-grouse	X	X	X			
Columbidae, pigeons, doves	X	X	X	X	X	X

TABLE 1—(*Continued*)

Family	*Region*					
	Palaearctic	*Ethiopian*	*Oriental*	*Australian*	*Neotropical*	*Nearctic*
Psittacidae, parrots, macaws, lories	x	X	X	X	X	x
Musophagidae, plantain-eaters		X				
Cuculidae, cuckoos, roadrunners, anis	X	X	X	X	X	X
Tytonidae, barn owls	X	X	X	X	X	X
Strigidae, owls	X	X	X	X	X	X
Steatornithidae, oil-birds					X	
Podargidae, frogmouths			X	X		
Nyctibiidae, potoos					X	
Aegothelidae, owlet-frogmouths				X		
Caprimulgidae, goatsuckers	X	X	X	X	X	X
Micropodidae, swifts	X	X	X	X	X	X
Hemiprocnidae, crested swifts			X	X		
Trochilidae, hummingbirds					X	X
Coliidae, colies		X				
Trogonidae, trogons		X	X		X	
Alcedinidae, kingfishers	X	X	X	X	X	X
Momotidae, motmots					X	
Meropidae, bee-eaters	X	X	X	X		
Coraciidae, rollers	X	X	X	X		
Upupidae, hoopoes	X	X	X			
Phoeniculidae, wood-hoopoes		X				
Bucerotidae, hornbills		X	X	X		
Galbulidae, jacamars					X	
Bucconidae, puff-birds					X	
Capitonidae, barbets		X	X		X	
Indicatoridae, honey-guides		X	X			
Rhamphastidae, toucans					X	
Picidae, woodpeckers, piculets	X	X	X	x	X	X
Eurylaimidae, broadbills		X	X			
Dendrocolaptidae, wood-hewers					X	
Furnariidae, ovenbirds					X	
Formicariidae, ant-thrushes					X	
Conopophagidae, ant-pipits					X	
Rhinocryptidae, tapaculos					X	
Cotingidae, cotingas					X	
Pipridae, manakins					X	
Tyrannidae, tyrant flycatchers					X	X
Oxyruncidae, sharp-bills					X	
Phytotomidae, plant-cutters					X	
Pittidae, pittas		X	X	X		
Menuridae, lyre-birds				X		
Atrichornithidae, scrub-birds				X		

TABLE 1—(*Continued*)

Family	*Region*					
	Palaearctic	*Ethiopian*	*Oriental*	*Australian*	*Neotropical*	*Nearctic*
Alaudidae, larks	X	X	X	X	x	X
Hirundinidae, swallows	X	X	X	X	X	X
Campephagidae, cuckoo-shrikes		X	X	X		
Dicruridae, drongos	X	X	X	X		
Oriolidae, Old World orioles	X	X	X	X		
Corvidae, crows, magpies, jays	X	X	X	X	X	X
Paradiseidae, birds of paradise				X		
Paradoxornithidae, parrot-bills, suthoras	X		x			
Paridae, titmice	X	X	X	X		X
Sittidae, nuthatches	X		X	X		X
Certhiidae, creepers	X	X	X	X		X
Chamaeidae, wren-tits						X
Timeliidae, babbling thrushes	X	X	X	X		
Pycnonotidae, bulbuls	X	X	X	x		
Cinclidae, dippers	X		X		X	X
Troglodytidae, wrens	X		X		X	X
Mimidae, thrashers, mockingbirds					X	X
Turdidae, thrushes	X	X	X	X	X	X
Zeledoniidae, wren-thrushes					X	
Sylviidae, Old World warblers	X	X	X	X	X	X
Regulidae, kinglets	X					X
Muscicapidae, Old World flycatchers	X	X	X	X		
Prunellidae, accentors, hedge sparrows	X					
Motacillidae, wagtails, pipits	X	X	X	X	X	X
Bombycillidae, waxwings	X					X
Ptilogonatidae, silky flycatchers					X	X
Artamidae, wood-swallows		X	X	X		
Laniidae, shrikes	X	X	X	X		X
Prionopidae, wood-shrikes		X	X	X		
Cyclarhidae, pepper-shrikes					X	
Vireolaniidae, shrike-vireos					X	
Sturnidae, starlings	X	X	X	X		
Melithreptidae, honey-eaters		x		X		
Nectariniidae, sunbirds	x	X	X	X		
Dicaeidae, flower-peckers			X	X		
Zosteropidae, white-eyes	X	X	X	X		
Vireonidae, vireos					X	X
Coerebidae, honey-creepers					X	
Compsothlypidae, wood warblers					X	X
Ploceidae, weaver finches	X	X	X	X		
Icteridae, blackbirds, troupials					X	X
Procniatidae, swallow-tanagers					X	

TABLE 1—(*Continued*)

Family	*Region*					
	Palaearctic	*Ethiopian*	*Oriental*	*Australian*	*Neotropical*	*Nearctic*
Thraupidae, tanagers					X	X
Catamblyrhynchidae, plush-capped finches					X	
Fringillidae, grosbeaks, finches, buntings	X	X	X		X	X
Number of families per region	69	79	78	72	86	62
Number of endemic families	1	7	0	7	31	1
Per cent of endemic families	1.4	8.9	0	9.7	36.1	1.6

NOTE: X denotes presence of family in region; x denotes presence of family in region but not a typical member.

An inspection of the table reveals that some further qualifications seem advisable. Some families, typical of a certain region, are found represented just over the border in an adjoining region by one or two species. This fact is indicated in Table 1 by a small 'x', denoting the family's occurrence in the invaded region. The element of personal opinion thus entered into the making of decisions as to whether a border-line case should be considered as a typical family of a given region. I have been guided in this matter by the judgment of Mr. Boulton, to whom I am indebted and grateful for help on this and many other points.

Of the 144 families listed in Table 1 almost one-fourth, 33 in fact, are found in all of Wallace's regions. They are about equally divided between terrestrial and aquatic families. The total number of families in any given region does not differ greatly from the number in any other region. The range between the 62 families of the Nearctic and the 86 families of the Neotropical is not very great. However, one is struck by the great variation in the number of endemic families, ranging from none in the Oriental to 31 in the Neotropical, a figure which is expressive of the distinctive character of the Neotropical region. The Ethiopian and Australian regions and the Palaearctic and Nearctic regions are close parallels in the matter of endemic families, a fact which will be recalled for consideration later. The Oriental region appears to have acted as a meeting point for Ethiopian, Palaearctic and Australian families of birds so the lack of endemic families is not surprising. Figures to show the degree of relationship between the Oriental and the three other regions mentioned above will be given later.

Almost as instructive as the endemic families are those groups of birds that occur in five of Wallace's regions but are missing from one region. Here again the Neotropical is most distinctly set off for it lacks the following families: Gruidae, Paridae, Certhiidae and Laniidae. The place of the Gruidae appears to be filled by the Psophiidae, a closely related family, in the Neotropical. The Paridae and Certhiidae appear to be families of northern origin which have not yet penetrated the Neotropical. The family Laniidae is mainly Old World in distribution. In addition, the family Alaudidae is poorly represented in the Neotropical. Larks are plains birds, dwellers in open country, and are evidently filtering into South America by way of the *paramos* of the Andes Mountains. They are restricted in their eastward distribution by the presence of the great tropical rain-forests of the Orinoco and Amazon River systems but they may be expected to spread out over the broad llanos and pampas of southern South America in the future.

The Nearctic region lacks the Rostratulidae and Burhinidae, two families which probably occurred there in the past but have been driven out or exterminated. The Ciconiidae are very sparingly represented in the southern part of the Nearctic by the Wood Ibis alone. The Wood Ibises, which include three Old World species, have been thought by some taxonomists to be worthy of family rank.

The Australian region lacks the Phoenicopteridae and Fringillidae. The absence of such an ancient group as the flamingos is difficult to explain satisfactorily. The Fringillidae is a very successful family which may be expected to become established in the Australian region eventually. The Picidae are just over the line in the Australian for they occur in some of the Moluccas. It seems quite possible that in the course of time they may occupy more of the Australian region although the isolation of the continent of Australia coupled with the fact that the woodpeckers are not very strong fliers may delay their establishment there for a long time.

A further inspection of Table 1 shows that there are certain families which are confined to two regions and are found nowhere else. This may be taken as evidence of close faunal relationship, at least as far as families of birds are concerned. There is no need to list these families for they can be easily abstracted from Table 1 but the figures are interesting: Palaearctic-Ethiopian, 1; Palaearctic-Oriental, 1; Palaearctic-Nearctic, 6; Ethiopian-Oriental, 3; Oriental-Australian, 4; Neotropical-Nearctic, 11. If one were to estimate degree of faunal relationship solely on this basis, then one would say that the Neotropical-Nearctic pair are most closely allied. But it

seems to me that there is a difference in the quality of the relationship between members of different pairs of regions. In the Palaearctic-Nearctic pair it is difficult to determine which families are predominantly Palaearctic, which Nearctic, a point in favor of combining the two and calling it the Holarctic region. Another relationship is indicated between the members of the Ethiopian-Oriental pair where there has been a fairly even exchange, the Indicatoridae being Ethiopian in origin and the Eurylaimidae of Oriental origin. The third type is the one-sided relationship existing between the Neotropical and the Nearctic where most of the families are Neotropical in origin, judging from the number of genera and species found there in contrast to the number of genera and species of the same families in the Nearctic. On this basis the Trochilidae, Tyrannidae, Mimidae, Ptilogonatidae, Vireonidae, Icteridae and Thraupidae are almost certainly of Neotropical origin. To estimate the closeness of relationship between the Neotropical and Nearctic, or between any two regions, solely on the basis of peculiar families in common seems unfair. It should be supplemented by a comparison of the number of families common (not necessarily peculiar) to the two regions. Table 2 does this for all the combinations of Wallace's regions.

TABLE 2

A NUMERICAL COMPARISON OF THE FAMILIES OF BIRDS IN EACH PAIR OF WALLACE'S REGIONS

Regions	*Total no. of families in two regions*	*No. of families common to two regions*	*Per cent of common families*
Palaearctic-Ethiopian	90	58	64.4%
Palaearctic-Oriental	85	61	71.2%
Palaearctic-Australian	87	54	62.1%
Palaearctic-Neotropical	116	39	33.6%
Palaearctic-Nearctic.	83	48	57.8%
Ethiopian-Oriental	87	70	80.5%
Ethiopian-Australian	91	60	65.9%
Ethiopian-Neotropical	123	42	34.1%
Ethiopian-Nearctic	100	41	41.0%
Oriental-Australian	86	64	74.4%
Oriental-Neotropical	120	44	36.7%
Oriental-Nearctic	96	43	44.8%
Australian-Neotropical	122	36	29.5%
Australian-Nearctic	95	39	41.1%
Neotropical-Nearctic	98	50	51.0%

According to the figures given in Table 2, the Ethiopian and Oriental regions are most closely related with 80.5 per cent of their families in common. The Oriental-Australian regions with 74.4 per cent and the Palaearctic-Oriental regions with 71.2 per cent of their families in common come next on the list. The fact that the Oriental region appears in all three of these most closely related combinations of regions is indicative of the lack of distinction in its fauna previously mentioned in connection with its lack of endemic families. Since the Ethiopian and Oriental regions were probably connected in the past, it is not surprising that they should be so closely related. One might expect the Neotropical and the Nearctic to show close affinities and indeed they do in the possession of 11 families found nowhere else, but as Table 2 shows, only 51 per cent of their families is common to both. We must, therefore, recognize that the Nearctic and Neotropical regions do differ to a considerable degree in spite of the comparatively large number of families peculiar to the two regions.

Table 2 might be applied to answer such a question as whether the Oriental region is more closely related to the Palaearctic region, with which it lies in contact on the north, or with the Australian region lying to the southeast. According to Table 2 the relationship is closer with the Australian and this conclusion is supported by the fact that the Oriental has four families in common with the Australian which are found nowhere else while it has only one peculiar family in common with the Palaearctic. Table 2 should be employed with some caution, I believe, and taken as indicating in a broad manner the degree of relationship between Wallace's regions. This is particularly true in those groups ranking near the bottom of the list, for any two regions, even at opposite ends of the earth, may be expected to show a certain percentage of common families as a result of the fact, previously noted, that there are 33 families which are cosmopolitan in their distribution and eight which are absent from only one of the six regions.

Sclater placed his four Old World regions in one group, Palaeogaea, and the two New World regions in another group called Neogaea. There are fourteen families found in all four of the Old World regions; they are: Turnicidae, Otididae, Glareolidae, Meropidae, Coraciidae, Dicruridae, Oriolidae, Timeliidae, Pycnonotidae, Muscicapidae, Sturnidae, Nectariniidae, Zosteropidae and Ploceidae. On the other hand, the New World has eleven families which are present in both the Nearctic and the Neotropical and are absent from the Old World. These families are: Cathartidae, Meleagrididae, Arami-

dae, Trochilidae, Tyrannidae, Mimidae, Ptilogonatidae, Vireonidae, Compsothlypidae, Icteridae and Thraupidae.

The Meropidae (bee-eaters) appear to fill an ecological niche in the Old World which is occupied by the Galbulidae (jacamars) of the New World. Other ecological equivalents might be mentioned: Muscicapidae (Old World flycatchers) and Tyrannidae (tyrant flycatchers), Nectariniidae (sunbirds) and Trochilidae (hummingbirds). It seems likely that the Nectariniidae, as an example of ecological equivalence, could exchange places with the Trochilidae, provided they could reach the New World. But the two families are separated by the Atlantic Ocean, making it extremely improbable that such an exchange will ever occur. Here we have an example of one of the barriers to the distribution of land birds, the ocean.

In addition to the ecological equivalents just mentioned there are some families in the Old World which are morphologically very close to certain of the New World families. The Zosteropidae (white-eyes) are structurally very close to the Vireonidae (vireos) and Compsothlypidae (wood warblers). Also the Ploceidae (weaver finches) resemble the Icteridae (blackbirds and troupials) and Thraupidae (tanagers) in that they are all specialized finches.

The Phoenicopteridae (flamingos) are found in the Ethiopian and Neotropical regions, in the southern Palaearctic, western Oriental and southeastern Nearctic. It is evidently an ancient group for the Phoenicopteridae are well represented by fossils, the oldest of these forms coming from the upper Cretaceous of Denmark. Other forms have been found in the middle and late Tertiary of Europe and a single Pliocene form from central Oregon, according to Knowlton and Ridgway.

The distribution of the Sittidae (nuthatches) seems to be in accord with Matthew's (1915) theory of the dispersal of vertebrates from a Holarctic center of origin. The nuthatches inhabit the forested areas of the Palaearctic, Oriental, Australian and Nearctic regions. From this distribution it would appear that the family arose somewhere in the Palaearctic and spread south through the Oriental and Australian regions and east across the Bering Strait into the Nearctic. It is probable that the desert character of most of northern Africa has prevented the family from entering the Ethiopian region. Its absence from the Neotropical can best be explained by the likelihood that the Sittidae have not had sufficient time to penetrate this region.

Two families, the Cinclidae (dippers) and Troglodytidae (wrens), show this distribution: Palaearctic, Oriental, Nearctic, Neotropical.

The dippers are found only where there are swift mountain streams and appear to have originated in the Palaearctic. They followed the mountains of the Palaearctic west to the Atlantic Ocean and east to Bering Strait, which they crossed, entering the Nearctic. They then came down the long chain of mountains extending from Alaska almost to the southern tip of South America. The dippers might flourish in the Appalachian Mountains of the eastern Nearctic but there are approximately 2,000 miles of mountainless country intervening. They occur in the Atlas Mountains of Africa but are prevented by the Sahara Desert from reaching the equatorial mountains of central Africa, where they might find suitable habitats. This distribution shows mountain chains acting as highways for birds but in a slightly different manner from that in which the highlands of the Andes are furnishing a road for the penetration of the Neotropical by the larks. The Troglodytidae are regarded as having their center of distribution in the Neotropical, whence they have spread into the Nearctic, Palaearctic and Oriental. They have not reached the Ethiopian and Australian regions although they are close to Wallace's Line in the Oriental and probably will spread into the Australian region in the future.

Still another combination of regions is that in which the Rynchopidae occur. The skimmers are found in the Ethiopian, Oriental, Neotropical and Nearctic regions along the coast and occasionally penetrate into the interior by means of large rivers, such as the Amazon of the Neotropical and the Congo of the Ethiopian. In the Nearctic they are found around the Gulf of Mexico and breed north to New Jersey and Long Island. This may be due to the warm Gulf Stream along that portion of the coast of the Nearctic.

The case of the Spheniscidae (penguins) offers a somewhat similar instance of an ocean current influencing the distribution of a group of birds. The penguins are typically birds of the Antarctic, but a single species occurs on the Galapagos Islands, which lie on the equator off the west coast of South America. Their presence here is believed due to their following the cold waters of Humboldt's Current, which parallels the west coast of the Neotropical. Thus we have the range of a tropical family extended by a warm current in the case of the skimmers and that of an Antarctic family by a cold current in the ocean in the case of the penguins. The Fregatidae (frigate-birds) and Phaëthontidae (tropic-birds) appear to illustrate the restriction of the range of families through temperature barriers for, although they are found around the world, they are restricted to tropical and subtropical seas.

The families Pterocletidae (sand grouse), Upupidae (hoopoes) and Pycnonotidae (bulbuls) are found in the Palaearctic-Ethiopian-Oriental group of regions. The sand grouse dwell in that great belt of desert and semi-desert country stretching across Africa from the western Sahara, the Syrian and Arabian deserts and the deserts of Asia to the Gobi. Their distribution is dependent on the presence of open country for they shun forests. They have advanced from the Sahara in Africa down the east coast of that continent and are found in the desert area of southwestern Africa. They have probably been prevented from populating the great desert tracts of Australia by the dense forests of southeastern Asia as much as by the distances involved. This is a case of the forest acting as a barrier to the distribution of a desert form.

Families peculiar to the Ethiopian-Oriental-Australian complex are: Bucerotidae (hornbills), Pittidae (pittas), Campephagidae (cuckoo-shrikes), Artamidae (wood-swallows), Prionopidae (wood-shrikes) and Nectariniidae (sunbirds). Most of these families are sparsely represented in the semi-desert regions of southwestern Asia; they are forest-dwellers by preference.

Another combination of regions is the Ethiopian-Oriental-Neotropical with three families not found elsewhere. These are the Heliornithidae (sun-grebes), Trogonidae (trogons) and Capitonidae (barbets). Their rather peculiar distribution seems best explained on the basis of Matthew's theory. This is supported by the fact that a fossil trogon is known from the Miocene of France, indicating a more northern distribution in the past.

The Oriental-Australian regions have four peculiar families: Megapodiidae (megapodes), Podargidae (frogmouths), Hemiprocnidae (crested swifts) and Dicaeidae (flower-peckers). The Hemiprocnidae are residents of the monsoon forest and tropical rain-forest of southeastern Asia and the East Indies. The absence of such a forest in Australia may explain their absence from that continent.

The Palaearctic-Nearctic regions have six families not found elsewhere. These are Gaviidae (loons), Tetraonidae (grouse), Phalaropodidae (phalaropes), Alcidae (auks), Regulidae (kinglets) and Bombycillidae (waxwings). The Gaviidae are known from the lower Miocene of France and the Pliocene of England yet in spite of this antiquity have not spread into the Southern Hemisphere. It would seem that there is a temperature barrier beyond which they do not pass. An illustration of a temperature barrier in members of another family, Laridae, was discovered by R. C. Murphy (1924). He mapped the lines of average over-surface temperatures in the North

Atlantic in June and found that the isotherm of 70 degrees Fahrenheit coincided with the southern boundary of the Common Tern, *Sterna hirundo,* while the isotherm of 80 degrees Fahrenheit coincided with the northern boundary of the breeding range of the Noddy Tern, *Anous stolidus.* It is quite possible that an isotherm might be found south of which loons do not breed.

The Alcidae are of interest as being ecological equivalents of the Spheniscidae of the Antarctic. Like them they nest on the coasts of polar regions and obtain their food from the sea. The Great Auk, now extinct, was an excellent example of convergence in evolution for, like the penguins, its wings were so reduced that the bird was flightless.

The Regulidae is a family of very small birds which seem to prefer the coniferous forest as a breeding ground. This, coupled with temperature, may determine their distribution.

In any discussion of the dispersal of birds the origin and fossil record of the group should be taken into account. It is generally accepted that the avian stock split off from a group of reptiles known as the pseudosuchians in the Triassic. The first birds appeared in the fossil record in the Jurassic and their primitive character is shown especially by the fact that they possessed teeth.

The most generally accepted theory today of the evolution and dispersal of land vertebrates is that of W. D. Matthew (1915). Two of his important conclusions are: (1) secular climatic change has been an important factor in the evolution of land vertebrates and the principal cause of their present distribution; (2) the principal lines of migration in later geological epochs have been radial from holarctic centers of dispersal.

In my description and discussion of the distribution of the families of birds, I mentioned several cases where the fossil record and present distribution seem to indicate a dispersal from the Holarctic into the subtropical and tropical areas. A search through the fossil record showed that the first genera of birds which still exist appeared in the middle Eocene. A few examples might be given of genera which once existed to the north of the region to which they are now confined. *Sarcoramphus,* now found only in Central America, is known from the California Pliocene; *Agriocharis,* now found in Yucatan, is known from the Pliocene of Arizona; *Jabiru* and *Geranoëtus* from the Pleistocene of the West Indies are now confined to Central and South America.

In comparison with the mammals, birds are rare as fossils and this leaves many gaps in the record, making a complete explanation

of their dispersal more difficult. I do not believe that the presence of the large number of families in the Neotropical region can be explained by assuming that they were all pushed down into that region from the Nearctic by a change in climate. Undoubtedly some of the richness of the Neotropical region in families of birds is due to the fact that it has acted as a haven for families driven down from the north by climatic changes. This is true also of the Ethiopian and Australian regions. However, the large number of endemic families in the Neotropical seems best explained by assuming that most of them arose there and this explanation would apply also to the endemic families of the Ethiopian and Australian. The number of endemic families in any region seems to me to be the result of the interaction of various factors among which are the following: (1) number of ecological niches into which different types of birds might evolve; (2) length of time during which climatic conditions have remained relatively stable, that is, without marked changes which would eliminate the families once formed; (3) degree of geographical isolation, which would tend to hinder the dispersal of families from the region in which they arose; (4) degree of freedom from predators.

The relative weight of these factors has undoubtedly differed among the different regions. For example, the Ethiopian and Australian regions each have seven endemic families but the isolation and predation factors are certainly of different value in the two regions. To judge from the results, the Neotropical has had an unusually favorable combination of factors influencing the formation and preservation of endemic families, the Ethiopian and Australian a distinctly less favorable combination, and the Palaearctic and Nearctic a still less favorable combination.

CONCLUSIONS

1. Birds as a class arose from reptilian stock in the Holarctic and spread out from this region.

2. Some families which arose in the Holarctic are now found only in tropical regions.

3. Other families, particularly some of those endemic to the Neotropical, Ethiopian and Australian, probably originated in those regions from more primitive families which may have had their origin in the Holarctic.

4. Other families, tropical in origin, have migrated in later geological times to regions lying to the north, e. g., some of the families peculiar to the Neotropical-Nearctic regions.

In the description of the distribution of certain families of birds a number of influential factors were mentioned, for example, ocean currents, separation of continents before the families had attained their present status and specialization to inhabit a certain type of vegetation. The confinement of whole families of birds to certain regions in spite of the fact that birds are the most mobile of terrestrial vertebrates seems sufficient reason for the division of the earth into faunal regions. Although Wallace's 'regions' are of unequal value, particularly with regard to endemic families, I believe that the division made is as fair as any that could be conceived without multiplying the number of regions to such an extent as to obscure the fact that there are broad faunal areas over the face of the earth as a consequence of its past history.

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FURTHER STUDIES ON TRICHOMONIASIS IN BIRDS

BY ROBERT M. STABLER

INTRODUCTION

IN a recent publication Levine, Boley and Hester (1941) give a thorough review of the literature dealing with the infection of birds and mammals (inoculation into mice, rats and guinea pigs) with *Trichomonas gallinae* (= *columbae*). To the list of birds already known to have harbored this pathogenic *Trichomonas* they have added as new (experimentally infected) hosts the Bob-white, Canary, English Sparrow and duck (type not given). They were unable to infect two Ring-necked Pheasants and a Starling, and found nine freshly caught English Sparrows free from a natural infection with this trichomonad.

It is the purpose of this paper to present the results of the examination of a large series of various types of birds for the presence of *T. gallinae*.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Dr. Herman A. Shelanski, of the University of Pennsylvania, for doing the cultivation work in the early stages of the investigation. He is most grateful to Mr. George W. Middleton and his sons, of the Whitehall Farms, Norristown, Pennsylvania, and to Mr. Wendell M. Levi, of the Palmetto Pigeon Plant, Sumter, South Carolina, for the donation of Kings and Carneaux used in this study. Through the kindness of the Philadelphia Zoölogical Garden several species of caged doves were made available for examination. The writer is also indebted to the Pennsylvania Game Commission for the permit allowing the handling of the protected species.

OBSERVATIONS

The birds used in this survey were examined while alive, or a very short time after their death. Material from the upper digestive tract was examined microscopically and by culture. The results are as follows:

Pigeons (*Columba livia*).—In all, two hundred and forty-two birds were examined. Of these, 35.5 per cent were free of *T. gallinae*, 64.5 per cent were infected. The birds were of three groups. Eight were bought in a Philadelphia market (source unknown)—all were positive. Forty-seven came from three separate pigeon farms raising squabs for market—one bird only was negative. The re-

TABLE 1

DATA ON INFECTED RAPTORIAL BIRDS

Type bird	*Mode of infection*	*Result*
Cooper's Hawk	Fed partly on pigeon.	Developed large caseous areas in mouth and throat. Caseation extended deep into tissues of pharynx. Throat completely closed. Bird died.
Red-tailed Hawk	Mouth smeared with material directly from the mouth of a positive pigeon.	Mouth and crop filled with large caseous areas. One large, firm, adherent mass involved the whole floor of the crop. Few small areas in the esophagus. Bird died.
Red-shouldered Hawk	Fed heads and crops of five positive pigeons.	No caseation. Excessive salivation noted, and membranes of mouth and crop much inflamed. Bird died.
Red-shouldered Hawk	Mouth smeared with material directly from the mouth of a positive pigeon.	Bird remained alive and healthy. Positive for *T. gallinae* after 49 days. Banded and released.
Red-shouldered Hawk	Fed heads and crops of seven positive pigeons.	Bird remained alive and healthy. Mouth and crop swarming with *T. gallinae* after 38 days.
Golden Eagle	Fed pigeons regularly.	Bird in extremely poor condition at time of death. Mouth and crop a mass of caseation. One area in crop so extensive that skin of neck inseparably adherent to it.
Pigeon Hawk	Bird accidentally allowed to eat one pigeon head.	No lesions or caseation. Much inflammation and excessive salivation at time of death.
Sparrow Hawk	Accidentally fed positive pigeon crop.	No lesions or caseation. Again much inflammation of the mouth and throat membranes, accompanied by excessive salivation. Bird died.
Sparrow Hawk	Food accidentally contaminated with positive pigeon-crop material.	Mouth, crop, throat, and even nasal sinuses, thoroughly involved with large caseation. Bird died.
Sparrow Hawk	Mouth smeared with positive material directly from positive pigeon mouth.	Bird remained completely healthy. Positive for *T. gallinae* when banded and released 110 days after infection.
Duck Hawk	Found infected in the eyrie. Probably contracted from the food-pigeons.	Bird remained alive and well for over two years as a trained falcon in the writer's hands. Finally flew off.
Duck Hawk	Sister to the above bird. Same method of infection undoubtedly.	Bird also remained completely healthy until it was released at four months.

maining one hundred and eighty-seven pigeons were taken from fourteen different locations in three States (Pennsylvania, Maryland and New Jersey). These were wild birds in every sense of the word and were caught for the most part in barns and other buildings at night. Slightly over one-half, 54.5 per cent, were positive for *T. gallinae.*

None of the birds was examined as a direct result of symptoms attributable to *T. gallinae.* Some few were old, others had visceral bacterial lesions, but by far the majority were healthy, normal pigeons.

Doves.—In this series, twenty-six birds of five species were available as follows:

10 Mourning Doves (*Zenaidura macroura carolinensis*)
5 Graceful Ground Doves (*Geopelia c. cuneata*)
2 Laughing Doves (*Streptopelia s. senegalensis*)
5 Ring-necked Doves (*Streptopelia d. decaocto*)
4 Blue-headed Quail-doves (*Starnoenas cyanocephala*)

Of these, only the Mourning Doves were wild birds. The others were caged in the collection of the Philadelphia Zoölogical Garden. None was positive for *T. gallinae.*

Domestic Turkey (*Meleagris gallopavo*).—A small flock of twelve birds which had the run of a farm in Pennsylvania were all negative for this parasite.

Raptorial birds.—A total of forty-one birds was examined, of which only two—a pair of nestling Duck Hawks—were found naturally infected with *T. gallinae.* Thirty-two were negative on first examination. Three of these (one Red-tailed Hawk, one Red-shouldered Hawk and a Sparrow Hawk) were subsequently purposely infected. Seven other positive birds, received from various sources, were also available for study. The thirty-two initially uninfected birds were as follows:

2 Cooper's Hawks (*Accipiter cooperi*)
2 Goshawks (*Astur a. atricapillus*)
1 Red-tailed Hawk (*Buteo b. borealis*)
4 Red-shouldered Hawks (*Buteo l. lineatus*)
1 Golden Eagle (*Aquila chrysaëtos canadensis*)
8 Duck Hawks (*Falco peregrinus anatum*)
5 Sparrow Hawks (*Falco s. sparverius*)
1 Pigeon Hawk (*Falco c. columbarius*)
2 Prairie Falcons (*Falco mexicanus*)
2 Screech Owls (*Otus asio naevius*)
1 Barn Owl (*Tyto alba pratincola*)
2 Great Horned Owls (*Bubo v. virginianus*)
1 Snowy Owl (*Nyctea nyctea*)

The data on the twelve infected birds may be found in Table 1. From this table it can be seen that seven birds died of the infection, four with extensive caseous lesions in the upper digestive tract, and three without lesions, but showing an inflammation of the membranes of the mouth and throat, accompanied by a profuse salivation. These birds all appeared to die of starvation, eating less and less as the infection progressed and finally refusing all food a day or so before death. In those with caseous involvements, actual mechanical obstruction often prevented swallowing. Those with no caseation seemed to experience such actual discomfort on swallowing that they, too, refused to eat, though they would frequently grab at food and tear it apart vigorously, still refusing to swallow even the smallest pieces. Evident discomfort was registered by all these birds throughout the period of infection by frequent gaping, swallowing and regurgitation movements. The other five birds remained alive and healthy despite their trichomonads.

Other birds.—All the birds in the following list were found to be entirely negative for *T. gallinae.*

1 Great Blue Heron (*Ardea h. herodias*)
1 Mallard Duck (*Anas p. platyrhynchos*)
1 Ruffed Grouse (*Bonasa u. umbellus*)
3 Bob-white (*Colinus v. virginianus*)
6 Ring-necked Pheasants (*Phasianus colchicus torquatus*)
1 Woodcock (*Philohela minor*)
1 Yellow-billed Cuckoo (*Coccyzus a. americanus*)
1 Nighthawk (*Chordeiles m. minor*)
3 Flickers (*Colaptes auratus luteus*)
1 Downy Woodpecker (*Dryobates pubescens medianus*)
3 Barn Swallows (*Hirundo erythrogaster*)
1 Blue Jay (*Cyanocitta c. cristata*)
4 Crows (*Corvus b. brachyrhynchos*)
6 Catbirds (*Dumetella carolinensis*)
5 Robins (*Turdus m. migratorius*)
1 Hermit Thrush (*Hylocichla guttata faxoni*)
1 Gray-cheeked Thrush (*Hylocichla minima aliciae*)
15 Starlings (*Sturnus v. vulgaris*)
1 Louisiana Water-Thrush (*Seiurus motacilla*)
3 Purple Grackles (*Quiscalus q. quiscula*)
3 Cowbirds (*Molothrus a. ater*)
26 English Sparrows (*Passer d. domesticus*)
3 White-throated Sparrows (*Zonotrichia albicollis*)

Summary of birds examined.—The above groups include a total of four hundred and twelve individual birds, representing forty-four species, twenty-two families and eleven orders. The total birds positive for *T. gallinae* (infected from all causes) were one hundred and

sixty-eight (40.8 per cent), of which twelve were raptores and one hundred and fifty-six were pigeons. The negative birds—two hundred and forty-four (59.2 per cent)—included twenty-nine hawks and owls, eighty-six pigeons and one hundred and twenty-nine other types. Of the three hundred and twenty-two strictly wild birds (not including the Domestic Turkeys, commercial pigeons, caged doves, etc., but including the barn pigeons, freshly caught raptores and other birds), only two types were infected, namely, pigeons (one hundred and two) and hawks (two Duck Hawks).

Discussion

One interesting fact revealed by this study is that such a high percentage of adult wild Common Pigeons harbor *Trichomonas gallinae*. They then constitute an important source in the spread of this parasite to whatever bird should feed upon them or eat and drink from vessels contaminated by them in their wanderings.

It should be noted that none of the ten wild Mourning Doves or none of the four species of caged doves, reared originally by regurgitational feeding as is the case with all columbid birds, was positive.

As a continuation of the experiments reported in abstract form by the writer, with Shelanski, in 1936 and again in 1937, we find three types of reaction to infection with *T. gallinae* in birds of prey. Some become positive and remain healthy; others, while showing signs of critical distress ending in death, develop no lesions; and still others show severe, obstructing, caseous involvements, also terminating in death. All of these birds swarm with the trichomonads, in the upper digestive tract only. It must be admitted that the possible rôle played by viruses or bacteria in these latter cases is as yet incompletely understood.

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A MIOCENE GULL FROM NEBRASKA

BY ALDEN H. MILLER AND CHARLES G. SIBLEY

IN collections made by the University of California Museum of Paleontology in 1933 in northern Nebraska is a portion of a humerus of an extinct gull. The bone was found in the Niobrara River Zone, locality V3306, known as Little Beaver A. This locality is in the northeast corner of the northeast quarter of sec. 18, T 34 N, R 26 W, Cherry County, Nebraska. The fossil was discovered on the Niobrara Game Preserve in a small sandy exposure about 75 feet east of a dry north-south ravine which drains into Little Beaver Creek. The matrix is a gray sand which forms a bed situated 65 feet above the Brule (?) Clay. This bed is Upper Miocene, as indicated by the associated mammalian genus *Monosaulax*, a beaver, which is restricted to that horizon.

The new gull from Nebraska may be known as

Gaviota niobrara new genus and species

Type.—Distal end of left humerus, about one-fourth complete, no. 30933 Univ. California Mus. Paleontology, field no. R. A. S. 680, from Upper Miocene, Niobrara River Zone, Cherry County, Nebraska. Collected by R. A. Stirton, May 20, 1933.

Characters.—Size of humerus as in *Larus hyperboreus*, but differing as follows: ectepicondylar spur shorter, with narrow base, and situated farther distally; axis of spur projects at less-acute angle to shaft. Olecranal fossa with a distinct, deeply excavated pit. Scar for attachment of pronator brevis located on medial side of ridge bordering impression of brachialis anticus rather than on summit of ridge as in *Larus hyperboreus*.

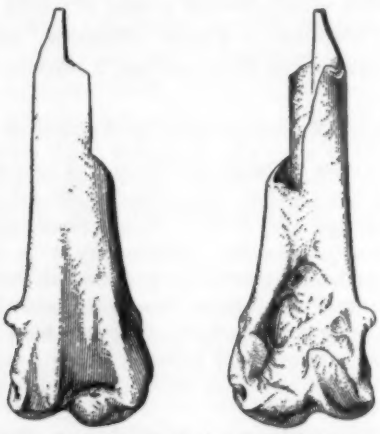
Measurements.—Transverse diameter across condyles, 19.7 mm.; distance from proximal base of ectepicondylar spur to most distal point of external condyle, 14.9; transverse diameter of shaft across proximal base of ectepicondylar spur, 15.2.

The condition of the ectepicondylar process or spur is fundamentally different from that in modern larids. Not only is the spur shorter, but it is placed farther distally on the shaft. This condition is summarized in the following table of comparisons. The transverse diameter across the condyles has been used as an index to the general size of the bone. The distance from the proximal base of the ectepicondylar spur to the most distal point on the external condyle has been divided by the transverse diameter in order to derive a ratio indicative of the relative position of the spur.

On the basis of the distal position of the ectepicondylar spur alone, the fossil seems to be close to the jaegers and to the shorebirds, such as *Numenius*. In terns the spur is placed farthest proximally. From the shorebirds, as exemplified by *Numenius*, to the terns there is a gradually changing ratio which indicates a shift proximally in the

position of the spur. An accompanying change, but one difficult to measure, occurs in the length of the spur. This follows the same trend, the process being shortest in the shorebirds and longest in the terns. In both of these characters the gulls are intermediate.

In order to determine the function of the ectepicondylar spur and the effect of changing its position and length, the wing of a Ring-billed Gull (*Larus delawarensis*) was dissected. The spur is the origin of the M. extensor metacarpi radialis longus, which is inserted on the extensor attachment of the proximal end of the carpometacarpus (metacarpal I). This muscle extends the distal segment of the wing. If the origin of this muscle is moved proximally from the



TEXT-FIG. 1.—Distal end of humerus of *Gaviota niobrara* (type, no. 30933 Univ. California Mus. Paleontology). Natural size. Anconeal aspect at left; palmar at right.

joint, an automatic extension of the distal part of the wing takes place whenever the elbow joint is straightened by the M. triceps. This is accomplished chiefly through tension put on the extensor metacarpi and its tendon, and little or no active contraction by this muscle itself is necessary. Thus a smaller muscle is sufficient to carry out the usual extensor actions and a saving in weight in the radial segment of the wing is accomplished. The same effect results from the lengthening of the spur. Since in the extinct *Gaviota* the spur is situated relatively far distally and in addition is the shortest spur of those examined, its condition appears to be primitive and suggests that the later trend of modification has been toward the development of a longer, more proximal ectepicondylar spur with attendant increase in efficiency.

The attachment of the pronator brevis is situated on the medial

side of the ridge bordering the scar of the brachialis anticus in *Gaviota*. This same condition is found in *Numenius* and other scolopacids. In the gulls and jaegers the scar of the pronator brevis is on the summit of the ridge.

Thus two characters, the positions of the ectepicondylar spur and the scar of the pronator brevis, point to relationships with the Scolopacidae. The much greater excavation of the area of attachment for the brachialis anticus, however, shows affinities to the larids. In the scolopacids (and jaegers) the brachialis scar is represented by a shallow depression and not by a deep excavation as in both *Gaviota* and modern gulls. In other characters of general configuration the fossil resembles the configuration of gulls in more respects than it does that of the shorebirds. Thus it seems that in *Gaviota* we have a form which in exhibiting characters of both groups may indicate that the two were more closely related in Miocene times and have diverged since then.

Species	*Number of specimens*	*Average distance from base of spur to end of condyle (1)*	*Average width across condyles (2)*	*1 : 2*
Gaviota niobrara	1	14.9	19.5	.76
Numenius americanus	4	10.8	13.8	.78
Recurvirostra americana	5	8.3	10.4	.80
Stercorarius longicaudus	1	9.8	11.0	.89
Stercorarius pomarinus	1	11.9	14.6	.82
Larus hyperboreus	2	18.0	19.7	.91
Larus glaucescens	11	15.8	18.0	.88
Larus occidentalis	11	14.6	16.7	.88
Larus argentatus	7	15.6	17.7	.88
Larus californicus	26	13.4	14.6	.92
Larus delawarensis	12	12.2	13.2	.92
Larus canus	10	11.3	12.0	.94
Larus philadelphia	6	8.8	9.4	.94
Larus atricilla	1	10.4	11.3	.92
Larus heermanni	11	11.5	12.9	.89
Rissa tridactyla	9	11.8	12.9	.92
Xema sabini	4	9.1	9.6	.95
Sterna forsteri	10	8.6	7.6	1.13
Sterna antillarum	1	5.3	4.6	1.15
Gygis alba	1	7.7	7.0	1.10
Thalasseus maximus	3	13.5	12.3	1.10
Thalasseus elegans	3	10.8	9.6	1.12
Hydroprogne caspia	2	15.2	14.0	1.09
Chlidonias nigra	5	6.5	5.6	1.16

Fossil gulls are surprisingly rare in North America. Shufeldt has

described three species of extinct gulls from this continent. *Larus oregonus* and *Larus robustus* (Amer. Nat., 25: 819–820, 1891) are from the Pleistocene of Oregon. *Larus pristinus* (Trans. Connecticut Acad. Arts Sci., 19: 54, 1915) is based upon a fragmentary tibiotarsus from the John Day Oligocene (?), and is of doubtful allocation.

Four species of fossil birds from Old World Oligocene deposits have been allocated to the genus *Larus*. *Larus desnoyersii* (Milne-Edwards, Oiseaux Fossiles de la France, 1: 344–349, 1867) is much smaller than *Gaviota*, with a width of 11.0 mm. across the distal condyles. The excellent illustrations (op. cit., atlas, pl. 54) show *Larus desnoyersii* to have but one deep fossa in the head of the humerus. The genus *Larus* is characterized by having two such fossae. In this respect *Larus desnoyersii* is similar to the Scolopacidae and Stercorariidae, which have but one fossa.

Larus elegans (Milne-Edwards, op. cit., 1: 350–357; atlas, pl. 57) is again much smaller than *Gaviota* (7.0 mm. across the condyles) and has a single fossa in the head of the humerus.

Larus totanoides (Milne-Edwards, op. cit., 1: 358–359; atlas, pl. 57) has a condylar width of 7.0 mm. The head is not preserved, but the angle of the external condyle to the axis of the shaft is less acute than in *Larus* and more like that in the Scolopacidae.

Although Milne-Edwards was aware of these departures from the typical larid condition, he undoubtedly was influenced in allocating these species to *Larus* by other associated skeletal parts which were more gull-like than the humeri.

The fourth species was described by J. Van Beneden (Bull. Acad. Roy. Belg., (2) 32: 256–261, 1871) as *Larus raemdonckii*. Judging from the illustration (p. 260) this bird appears to be allied to the Procellariiformes and probably should be placed in that group.

From the Miocene of Argentina, Mercerat (An. Soc. Cient. Argent., Buenos Aires, 43: 237, 1897) described the genus *Pseudosterna* which he placed in the Laridae. This genus is characterized by more distal placement of the ectepicondylar process than in modern *Larus*. This indicates a condition similar to that found in *Gaviota*, but the relative size of the process itself is described as the same as in *Sterna*. This would make the process larger than in *Gaviota*. In general size *Pseudosterna* was a much smaller bird, measuring 11.5 mm. across the condyles as compared with 19.5 mm. in *Gaviota*. Since no illustration accompanies the description of *Pseudosterna* it is difficult to evaluate the characters accurately, but it seems extremely unlikely that *Pseudosterna* and *Gaviota* are synonymous.

Museum of Vertebrate Zoology
Berkeley, California

GENERAL NOTES

An unknown loon from the Miocene fossil beds of Maryland.—Among recent accessions in the fossil collections of the U. S. National Museum there is included the distal end of a right tibiotarsus of a loon (Cat. no. 16612) presented by Mr. Arlton Murray. The bone was found by the donor, March 6, 1941, on the shore of Chesapeake Bay about one mile south of Plum Point Wharf, Calvert County, Maryland, and comes from the Calvert formation of the Miocene.

It represents a species of the genus *Gavia* slightly smaller than modern *Gavia immer*, but differs somewhat in conformation from that species. As the bone has been considerably worn by beach wash, all projecting points have been cut away so that though it is unquestionably a species not at present recognized it does not seem desirable to give it a name from this imperfect specimen. It serves merely to record the family from the Miocene where loon remains have not been identified previously in North America.—ALEXANDER WETMORE, *U. S. National Museum, Washington, D. C.*

Double-crested Cormorant breeding in Massachusetts.—It is well known that the Double-crested Cormorant (*Phalacrocorax a. auritus*) has been rapidly extending its breeding range along the New England coast during the decade and a half since E. H. Forbush wrote ('Birds of Massachusetts,' 1925): ". . . Black Horse Ledge near Isle au Haut—the southernmost known breeding-place on Atlantic coast and the only known breeding-place in Maine. . . ." It is now possible to report that this extension has reached the vicinity of Boston, Massachusetts, for on August 5, 1940, I went ashore on Shag Rocks, 800 yards east-northeast of Boston Light at the entrance of Boston Harbor, and found a good-sized colony.

These rocks had undergone a striking transformation since I last saw them five or six years before. I remembered them as gray and brown in color; now their upper slopes were chalky white in the afternoon sun as we approached from the west, while sitting in ordered ranks along the whole crest were not less than two hundred and fifty cormorants. The adults gradually took flight by scaling off the heights and flapping away to neighboring islets, but there remained nearly a hundred juveniles. We counted fifty-three nests in all, of which one contained three fresh eggs, two a pair each of the naked shiny-black young, and the rest were trampled flat by their grown occupants. There were also a few Herring Gulls' nests.

This colony is probably of several years' standing. The presence of cormorants during the summer and the increasing whitewashing of the rocks were noted by a number of people at least two years ago, and in 1939 this Department had several reports of the matter from the captains of its patrol boats. Mr. Francis H. Allen also had reports, including a circumstantial story of nests and eggs. Mr. Allen was much more active in checking these reports than anyone else, and I regret that continued bad weather during July and his absence from home in early August prevented his making the actual discovery. He has kindly put me in touch with Mr. Edward R. Snow of Winthrop, who is somewhat of an authority on the history of the islands in Boston Harbor, and who assures me the cormorants began nesting at Shag Rocks at least as early as 1937. Double-crested Cormorants are regularly summering at the present time on the whole of the Massachusetts coast. They are particularly common in Buzzard's Bay, where on June 16 and 17, 1941, I saw good-sized groups at Gull Island off Cuttyhunk, in Quick's Hole,

along the west shore of Cuttyhunk, on the Weepecket Islands, and off the Fairhaven shore. The great majority of these were immatures, but on the smallest of the Weepeckets was a sprinkling of fully adult birds whose behavior approached that of nesting pairs. Although we found no nests, it is possible a colony is in process of formation.—JOSEPH A. HAGAR, *Massachusetts Department of Conservation, Boston, Massachusetts.*

Cormorants killed by lightning.—In 'The Auk,' vol. 58, page 91, 1941, Frederick C. Lincoln gives one of the "few substantiated cases" of birds being killed by lightning. The record concerned some 33 pelicans so done to death near Nelson, Nebraska, on April 4, 1939. The writer was not aware of the scarcity of authentic reports of such happenings, but, upon reflection, realizes that such is the case! While it undoubtedly occurs at times, there must be few occasions when an observer is on the spot at the right moment. Therefore, in view of this, so ably brought out by Mr. Lincoln, the following should be of interest as it is of undoubted and absolute accuracy, and happening so closely on the appearance of the above note, is the more striking.

On April (curious coincidence) 11, 1941, a portion of Low-Country South Carolina was visited by a heavy electrical squall, accompanied by a decided precipitation of hail. Most of the disturbance centered in parts of Charleston County. At Point Farm, Wadmalaw Island, four gentlemen were inspecting a large field of cabbage about 2 p. m., when the squall broke. A flock of birds was passing overhead at the time. Suddenly, a bolt of lightning, instantly followed by a "terrific clap of thunder" split the cloud, and four birds were seen to fall headlong from the flock. Three of the four were picked up dead. One fell in a thicket and could not be found. These proved to be Double-crested Cormorant (*Phalacrocorax a. auritus*), in good spring plumage as they possessed "a puff of feathers like a small top-knot above each eye" according to one of the observers.

The birds were definitely identified by Rev. T. A. Beckett, Jr., of Wadmalaw Island, to whom they were taken. This gentleman has a well-deserved reputation in knowledge of natural history, and has been known to the writer for many years. It is through him that the above information was made known to me, and it constitutes, as far as I know, the first such instance for this area.—ALEXANDER SPRUNT, JR., *R. F. D. 1, Charleston, South Carolina.*

Little Blue Heron nesting in Massachusetts.—On June 21, 1940, my son, Frederick A. Hagar, returned from a visit to the Black-crowned Night Heron colony at Tilden's Island, Marshfield, with the report that at least two or three adult Little Blue Herons (*Florida c. caerulea*) were in the rookery and refused to be driven from a certain rather restricted portion of it. I was there myself the next morning and soon located four birds which gave every indication of being two mated pairs. We determined to make a thorough search for a nest, and enlisted the assistance of my nephew, Donald Chisholm Hagar, Jr., as an additional beater. Our first try on the morning of June 23 was not fruitful except that we worked out a method which later proved successful. We found that the birds could always be flushed from the immediate vicinity of a clump of large red cedars on the eastern slope of the island, and that soon after our withdrawal they would return to the tops of these trees, stand guard a few minutes, and eventually drop down into the tangle of cat-briers, wild-cherry bushes and sumac which formed the undergrowth. It was impossible to see anything from close at hand, but by standing far enough out in the marsh so that the herons paid me no attention, and

having the boys alternately flush them and withdraw while they settled down again, I was able to mark rather closely the point of departure and return. We examined dozens of nests in this area, high and low, and found nothing but young night herons or eggs.

At our next visit on July 13, there were still four birds, but one pair fed on the marsh throughout our stay and were obviously not nesting. The other pair was even more reluctant to be driven away than before, and repeatedly returned to the vicinity when we were within twenty feet of the flushing point. The young night herons were either flying or climbing in the treetops by this time, and in the dirt and confusion we missed the Little Blue Heron's nest, although we must have passed under it a dozen times.

On July 28, an adult flushed from the usual spot as soon as Frederick went in, and this time circled low overhead, croaking in a subdued harsh tone. It was still necessary to flush her once more, but twenty minutes later a bit of white fluff waving above the rim of a flattened nest ended the search. It was close to the trunk of a large cedar tree, about ten feet from the ground, and contained four young birds of which one was notably larger and better feathered than the others. All showed white feathers coming through on the back, and the greenish-yellow legs were entirely different from those of the young night herons.

On July 30, David L. Garrison and E. A. Benchley, Jr., visited the nest with us. All the young birds had grown fast, and two of them left the nest at our approach to scramble higher in the tree. August 6, David A. Aylward was there with us and took a series of pictures which amply substantiate the record. The most advanced bird was well feathered, and showed plainly the diagnostic slaty tips to the primaries. On August 9, Dr. and Mrs. Richard Tousey helped band three of them and took additional pictures, but the largest was so nearly ready to fly that we were unable to catch it. At our final visit, August 22, with Mr. and Mrs. Hervey B. Elkins, the two adults and one flying juvenile were feeding in the marsh close by. As we approached the nest one of the adults attended us overhead, croaking repeatedly, and we felt sure at least one more juvenile was nearby in the treetops. The 'runtiest' of the brood hung dead near the nest, its neck caught in a crotch.

In view of the excellent pictures and the number of people who saw these birds, and the evident possibility of their becoming regularly established, it seemed unnecessary and unwise to collect specimens. This decision was further justified on June 7, 1941, when Frederick and Chisholm found two mated pairs back at the site of the previous year's nesting, and both solicitous. The boys visited the island at weekly intervals and determined that one nest at least was in a small group of pitch pines and cedars, but again it proved difficult actually to locate the eggs. On July 13, however, we found three young birds about a week old. There were three pairs of adults in the rookery at this time, of which only one pair was completely indifferent to our presence. I have not made a complete search of the literature, but in going through the more obvious sources have not discovered any recent breeding record for the Little Blue Heron north of southwestern New Jersey, on the Delaware below Camden. Even old records seem to be entirely lacking north of New Jersey.—JOSEPH A. HAGAR, *Massachusetts Department of Conservation, Boston, Massachusetts.*

Yellow-crowned Night Heron in Wisconsin.—A first record for the Yellow-crowned Night Heron, *Nyctanassa violacea,* in Wisconsin was made May 15, 1941, at Kern

Park, a heavily wooded strip along the Milwaukee River, less than two miles from the heart of Milwaukee. The discovery was made by our party of five members of the Bird Study Group of the City Club, while making their annual field survey of the Milwaukee area. The heron was first noticed by the writer high in an elm tree near the river where it posed for a long time in an opening that afforded an unimpeded view. The other members of the group were Mrs. Amos P. Balsom, secretary of the organization, Mrs. Harold H. Tucker, Mrs. Charles O. Decker, Jr., and Mrs. Carl Kloo, all of whom fully confirmed the identity of the bird. On the following day, Mr. Owen Gromme, curator of higher zoology at the Milwaukee Public Museum, and his assistant, Mr. Marvin Adams, accompanied the writer to the park and found the heron in the same spot.—MARTHA ANDERSON WYMAN (MRS. PHELPS WYMAN), *759 N. Milwaukee St., Milwaukee, Wisconsin.*

A Mallard-Pintail hybrid.—On December 12, 1940, Mr. Peter Loring, of San Antonio, Texas, killed a strange duck in St. Charles Bay, Aransas County, Texas. It was mounted by Mr. Ben Earp, of the Game, Fish and Oyster Commission. According to him, it was a male with undeveloped testes, and weighed two and one-half pounds. He called the specimen to my attention. The head of the duck was green, but not as bright as that of the Common Mallard. The bill was grayish blue like that of a Pintail. Instead of there being a white ring around the neck, with the green ending sharply, the neck had two white, roughly triangular patches of feathers running back some two inches on the sides. The breast and back were colored like those of a Mallard except that they were lighter. The wings resembled a Mallard's. The feet were yellow, being somewhat lighter than those of the Common Mallard. The tail-feathers were the long spikes of the Pintail, but showed the Mallard influence by being slightly recurved. It was concluded that this duck was a hybrid between the Common Mallard, *Anas platyrhynchos platyrhynchos,* and the American Pintail, *Dafila acuta tzitzihoa.* The duck is now in the hands of its owner in San Antonio.

Another Mallard-Pintail hybrid was killed at Avoca Island, Louisiana, by Mr. J. T. Upton, on November 24, 1935. It was also a male. It was recorded in an unsigned article by Daigre (Louisiana Conservation Review, 5, no. 3: 25, 1936).—GORDON GUNTER, *Game, Fish and Oyster Commission, Rockport, Texas.*

European Widgeon in Delaware.—On December 8, 1940, at the Bombay Hook National Wildlife Refuge, near Leipsic, Delaware, I observed an adult male European Widgeon, *Mareca penelope,* under very ideal light conditions. The bird was located in an artificial lake about one-quarter mile from Sanctuary Headquarters. On this particular morning, I had already identified eleven species of ducks in this lake, when I noticed two adult male Baldpates, showing every detail of coloration in the clear morning atmosphere. Suddenly, I noticed a duck with a rich-brown head come out from behind the Baldpates. In another second the bird's full body was disclosed, showing the unmistakable markings of a European Widgeon, including the buff forehead, which I had not seen clearly on the bird at Hempstead Reservoir, Long Island.

Mr. John Herholdt, the Sanctuary manager informs me that this is the first European Widgeon record for the Refuge, and one of the first for Delaware. The bird was observed until December 11.—HERBERT S. CUTLER, *5517 Master St., Philadelphia, Pennsylvania.*

Food detection by vultures and condors.—In the literature on food-finding by birds, discussions of the use of smell seem to me to have neglected the possibility of secondary visual and auditory clues. Birds are not the sole animals to be attracted by carrion and it seems possible, especially in tropical forests, that carcases have attracted mammals or insects—flies and butterflies, for example—that might escape the attention of even the most careful naturalist. It also seems possible that carrion-eating birds have learned to associate the presence of these animals with possible food.

In an attempt at a single experiment to exclude all but visual cues, on July 15, 1940, I had two sheep killed in the coastal desert of Peru, some twenty kilometers south of Pisco. This desert strip is one of the most sterile in the world and one may travel, literally, for miles without sight of a living plant or animal. Condors (*Vultur gryphus*), however, cross it, *en route* from breeding grounds in the high Andes to feeding areas along the coast; and Turkey Vultures (*Cathartes aura jota*) and Black Vultures (*Coragyps atratus foetens*) constantly cruise its margins foraging for food.

The sheep were placed a half mile from the sea and several times this distance from terrestrial vegetation. The first was covered with a single layer of gunny sacks, held down by small stones; the slightest tug would have removed the covering. Blood ran through the cloth but the formlessness bore no resemblance to any prey likely to be encountered by the birds. The second sheep was slaughtered about 400 meters away and left in the open. Both carcases were eviscerated to hasten decomposition. Within an hour, both species of vultures, and several Condors, were circling over the exposed sheep.

Two days later the carcases were visited. The exposed sheep had decomposed enough for the birds to begin work (decomposition sets in slowly in the dry, desert air) but it was obvious they had not made much headway. They were gathered in a knot about the sheep and left reluctantly when we drove up. The covered sheep remained disregarded.

By this time there was a perceptible odor—and a small number of flies about twice the size of the familiar *Drosophila!* The presence of these insects, which had found the carrion across a half-mile of sterile desert, of course introduces an undesirable factor into the experiment since they might, possibly, have been visible to the birds. However, though they laid eggs in the hidden carcase, which in two days more smelled to high heaven, they did not serve as a cue to the birds, which cleaned up the exposed sheep and paid no attention to the concealed one.

While this experiment casts only dubious light on the part that insects may, or may not, play as indicators of carrion to birds, it seems to present some evidence that, at least on the coast of Perú, the Black and Turkey Vultures, and the Condor, do not find their food by use of the olfactory sense. Whether or not this is a geographic variation in behavior, characteristic only of these birds, and to be correlated with the lack of concealing cover, can be determined only by laboratory investigations.—WILLIAM VOGT, *Casilla 2147, Lima, Peru.*

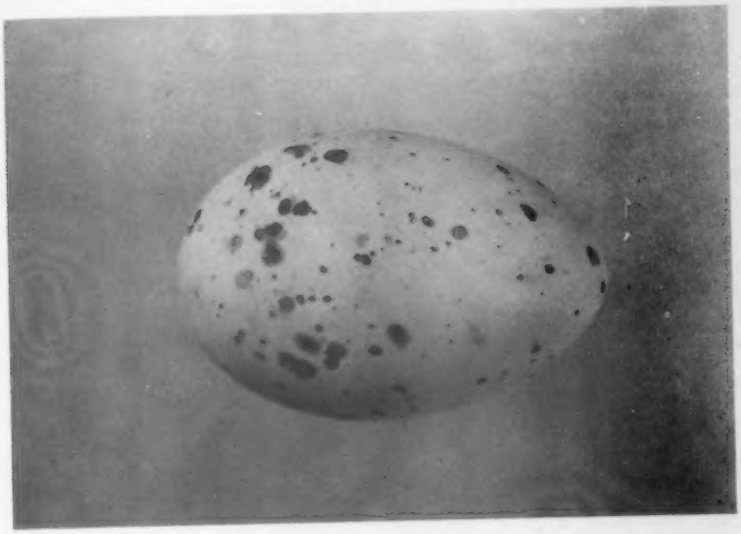
[In this connection see the article by P. J. Darlington, 'Notes on the Senses of Vultures' (Auk, 47: 251–252, 1930), in which it is suggested that vultures may be drawn to decaying animal matter by seeing the swarms of certain flies or carrion-eating beetles that come to it. Evidently, carefully devised experiments are needed to test the idea.—Ed.]

Eastern Goshawk nesting in southern New Hampshire.—On March 6, 1941, my son, Jackson Miles Abbott, found a nest, at the time unidentified, in the foothills of Mt. Monadnock, southern New Hampshire. Two downy, grayish feathers were on the rim of the nest, which was about 38 feet up in a triple crotch of a white pine, and twenty feet down from the feathery-needled top, with hardly a branch between the nest and the ground and very few between the nest crotch and the crown of the pine. On March 29, my son again ascended to the nest and found the nest now well feathered, but the owners were not to be seen. He returned to the site on April 8, and found two Eastern Goshawks (*Astur atricapillus atricapillus*), one in adult the other in less mature plumage, screaming defiantly at his intrusion. On April 12, I went with my son, and when we were within two hundred yards of the site the shrill *keee-yr* of the goshawks rang through the woods. The more mature bird swooped low through the trees several times—twenty feet above the ground—circled constantly overhead while we were there and screamed insistently, both while wheeling and when perched in trees within a hundred yards. On April 24, we again visited the site. The immature hawk flushed from the nest (this was the first time that we had seen a bird on the nest) when we were within one hundred feet, and I assumed it was the female. My son climbed to the nest and found it contained three eggs which were photographed *in situ*. During this time the more adult bird was the only one in evidence; the other made but a single circling of the treetops. At no time did either hawk come closer than seventy-five feet, although they screamed persistently, a shrill *keee-y* or *keee-yr* with very little of the cackle or *cac-cac-cac* so often used to describe a goshawk's scream.

The eggs (Plate 19) showed a gray ground color with a distinct bluish cast, covered with cloudy gray splotches. Two of the eggs were liberally sprinkled with red-brown and sepia spots and small blotches. The third was unmarked and appeared like a very large Cooper's Hawk's egg. All were larger and rounder than the eggs of a Red-shouldered Hawk. According to Bent he has "never seen or heard of a spotted egg" (Bull. U. S. Nat. Mus., no. 167: 128, 1937).

The nest, not unusually large, was about two and a half feet in its greatest diameter and was made of white-pine sticks ranging from three-quarters to one-quarter of an inch thick. It was built on an old foundation of possibly a Crow's or a Red-tailed Hawk's nest and was lined with chips of white-pine bark and decorated with five or six sprays of green needles of the white pine and one secondary flight feather of the younger bird. A few grayish downy feathers were caught on the nest rim and surrounding twigs. The nest tree was on a sloping hillside at about 1600 feet elevation, in not very dense woods of pine, spruce, beech, birch and maple, though few white pines were in this part of the woods. The remains of a Ruffed Grouse, one hundred feet from the nest, were the only immediate signs of predation; but a pair of Hairy Woodpeckers was breeding within two hundred yards of the goshawks' tree, Hermit Thrushes were singing within that distance and two Golden-crowned Kinglets were flitting over the nest tree as it was climbed.—Jacob Bates Abbott, *Dublin, New Hampshire.*

Red-shouldered Hawk eating a Wood Duck.—On April 6, 1940, while looking for birds along the Passaic River near Chatham, New Jersey, I flushed a Red-shouldered Hawk, *Buteo lineatus lineatus*, from the grass which was growing along the river. Thinking that it was odd for a Red-shouldered Hawk to be on the ground, I investigated and found the remains of a Wood Duck, *Aix sponsa*.



SUTTON AND SEMPLE: EGG OF THE MARBLED MURRELET

ABBOTT: EGGS OF THE EASTERN GOSHAWK

UNIV. OF MICH.

Probably the duck had been killed, or found dead on the river by the hawk. The breast and most of the belly had been removed, but the head as yet had not been touched. It was interesting to note that the hawk had not as yet eaten the eyes. I was unable to determine the physical condition of the bird before its death, but by the looks of the remains I would say that the duck had met its death within an hour or two before I found it. *Rigor mortis* had set in and the bird was cold, but as the weather was fairly cool this factor may have hastened the reaction.—WILLIAM F. RAPP, JR., *Rutgers University, New Brunswick, New Jersey.*

Further notes on wintering of the Rough-legged Hawk in Florida.—In 'The Auk' (57: 564, 1940) the writer gave all the records then available for the occurrence of *Buteo lagopus sancti-johannis* in Florida, pointing out that, apparently, these had been additions to the ornithology of the State, since A. H. Howell made no mention of the species in his 'Florida Bird Life' (1932). With what has transpired since, and another winter in the background, it may be well to sum up what could be called the present status of the bird. Reference was made in the above-mentioned 'Auk' item, to an observation of the species during the Audubon Wild-life Tours about Okeechobee during the winter of 1940. This project was again undertaken in February and March, 1941, conducted by the writer, and assisted this year by Alden H. Hadley, Audubon Educational Representative for Florida. The following observations of this large hawk were made in the field on these trips.

February 1—One observed at north city limit of Okeechobee, soaring at about 100 feet, Okeechobee County (Sprunt and Jacques, F. L.).

February 7—Two observed on Fort Bassenger Prairie, four miles *north* of State Road 8 (Arcadia to Okeechobee) and 16 miles west of Okeechobee (Hadley), Glades County.

February 11—Two observed on Seminole Indian Reservation, Glades County, ten miles *south* of Road 8 and about eight miles north of Lake Okeechobee (Hadley).

February 14—One seen about fifty feet over Road 8, five miles west of Okeechobee City, Okeechobee County (Sprunt).

February 24—One seen at Worm Cove, Lake Okeechobee shore, Glades County, about six miles east of Lakeport (Sprunt). This bird was sitting in a guava bush and was approached to within about sixty feet.

Here then, are five observations, involving seven birds, though it is impossible to say how many different individuals there were. However, because of the considerable distances that separate the records, it is safe to assume that more than two are accounted for.—ALEXANDER SPRUNT, JR., *National Audubon Society, Charleston, South Carolina.*

Purple Gallinule nesting in Virginia.—An article by Dr. J. J. Murray (Auk, 57: 566, 1940) calls for comment, as to the occurrence of the Purple Gallinule (*Ionornis martinica*) in Virginia since 1891. My father, H. B. Bailey, while collecting on Hog Island, Northampton County, Virginia, took a set of four eggs of the Purple Gallinule, on June 17, 1916. He flushed the bird from the nest, and this set is still in the Bailey collection. The nest had been found a few days previous with more eggs in it, was left for a larger set, but on returning to it later, he found one egg of the four left had been pecked by a Fish Crow, during the absence of the parent. No doubt the crow had secured several other eggs before the parent returned. As this was at the time, the farthest-north breeding record for this bird,

this damaged set has always been kept in the Bailey collection as a Virginia record, and I think it was recorded as such in one of the bird magazines soon afterward.—HAROLD H. BAILEY, *Coral Gables, Florida.*

Unusual water- and shorebirds in the Illinois River Valley.—Recent years have brought remarkable changes to the avifauna of the Illinois River Valley. In 1938, a tremendous post-nuptial influx of American Egrets occurred and with them a number of rare southern herons. These records, together with those of other unusual water- and shorebirds, are here listed.

WHITE PELICAN, *Pelecanus erythrorhynchos.*—The White Pelican is of rare occurrence over most sections of Illinois, although reported to be a regular migrant along the Mississippi River. There are no recent records for the Illinois River Valley. Consequently, the following observations are worth recording. On October 16, 1939, I saw two individuals flying over Lake Senachwine, five miles north of Henry. With an 8 × 40 binocular, I saw another one on Patterson Bay, near Bath, Illinois, on May 3, 1940; and on May 24, several other members of the Illinois Natural History Survey and I observed seventeen individuals on Clear Lake, fifteen miles north of Havana. One White Pelican was seen, April 26, 1941, on Beebe Lake by Ferd Luthy of Peoria.

SNOWY EGRET, *Egretta thula thula.*—Little is known of this egret in central Illinois. I observed five Snowy Egrets among large numbers of American Egrets at Cuba Island, Chandlerville, Illinois, on July 30, 1938. I observed them many times at close range; their black legs and yellow feet were noted, as well as the lack of bluish color on the under primaries. On September 27, 1938, Ferd Luthy and I watched three of these egrets with 8 × 30 binoculars at Duck Island, Banner, Illinois. We compared them with nearby American Egrets and Little Blue Herons.

YELLOW-CROWNED NIGHT HERON, *Nyctanassa violacea violacea.*—Since I found this species nesting in the Illinois River Valley (Auk, 55: 122, 1938), I have seen numerous other individuals along the river. I noted one adult near the confluence of the Illinois and Mississippi Rivers at Grafton, July 9, 1938; five immature birds (which were readily distinguished from immature Black-crowned Night Herons) on Sangamon Bay, Browning, Illinois, August 23 and 24, 1938. On July 21, 1940, I saw an adult of this species on Gilbert Lake, near Grafton.

WHISTLING SWAN, *Cygnus columbianus.*—While Whistling Swans in recent years have appeared regularly in the Chicago region, there are few records of this species in the Illinois River Valley. I saw one swimming about an ice-incased opening with numerous Mallards and Lesser Scaups on the Starved Rock navigation pool, near Ottawa, January 2, 1939. One immature Whistling Swan was shot by a hunter on Lake Chautauqua, November 13, 1940. The bird was confiscated by Patrolman Milford Smith of the U. S. Fish and Wildlife Service and is now in the collection of the Illinois Natural History Survey. Another individual was seen, November 16, 1940, at Lake Chautauqua by Arthur S. Hawkins of the Illinois Natural History Survey and several others.

HUTCHINS'S GOOSE, *Branta canadensis hutchinsi.*—Notwithstanding the few definite records of this goose in Illinois, it appears to be more common than is generally believed. A crippled Hutchins's Goose was kept for many months at the Brownstone Club, Bath, Illinois. In July 1938, it was measured by C. T. Black and the writer, who definitely determined it as *hutchinsi.* On October 18, 1939, Harry Anderson of the Illinois Natural History Survey and I saw one Hutchins's Goose at Crane Lake, near Snicarte, and on October 23, 1939, we saw twenty-five of these

geese at the same place. On October 23, 1940, I saw 118 Hutchins's Geese at Crane Lake and four on Lake Chautauqua, October 31, 1940. Small size, short necks, and high-pitched calls readily distinguished them from nearby Canada Geese. Two specimens of this small goose were secured for the Illinois Natural History Survey collection. One was killed five miles northeast of Havana by U. S. Senator C. Wayland Brooks, November 7, 1940; the other specimen was taken by Homer Bradley of the U. S. Fish and Wildlife Service, fifteen miles north of Havana, December 16, 1940.

The only spring record is that of an individual seen by Arthur S. Hawkins and Lyle K. Sowls on Spring Lake, near Banner, March 30, 1940.

WHITE-FRONTED GOOSE, *Anser albifrons albifrons*.—There are few records of the White-fronted Goose in Illinois. According to the 'Birds of the Chicago Region,' specific records of its capture in that region are lacking. Nevertheless, according to old-time hunters, this species appeared regularly but in small numbers each fall along the Illinois River and has become rarer in recent years.

I have observed this species on two occasions along the Illinois River. On April 30, 1938, at Duck Island, near Banner, twenty White-fronted Geese were feeding in a winter-wheat field along with forty Blue and four Lesser Snow Geese. Fourteen 'Speckle-bellies' flew from Crane Lake directly over my head on October 11, 1940. The speckled breasts of the several adults in this group were easily discernible.

GREATER SCAUP DUCK, *Nyroca marila*.—There are few definite records of the 'Big Broadbill' in Illinois, and most of these records are from the vicinity of Lake Michigan. I picked up a dead scaup, November 16, 1940, at Liverpool, which on examination proved to be an adult male Greater Scaup. It was made into a skin and is now in the collection of the Illinois Natural History Survey.

OLD-SQUAW, *Clangula hyemalis*.—A common wintering duck on Lake Michigan, this species is rare inland. I saw a pair at close range, with an 8×40 binocular, on Peoria Lake, November 8, 1940.

WHITE-WINGED SCOTER, *Melanitta deglandi*.—Uncommon on Lake Michigan at Chicago, this species has not been recorded recently in the Illinois River region. A crippled White-winged Scoter was seen by Jacob H. Lemm and the writer on Peoria Lake, November 8, 1940. After considerable pursuit, Mr. Lemm collected the bird, which is now in the Illinois Natural History Survey collection.

SURF SCOTER, *Oidemia americana*.—A hunter firing at several Coots on Lake Chautauqua, October 24, 1940, was surprised to retrieve an unknown "black" duck. The bird was secured by Homer Bradley, refuge manager. Identified as an immature female Surf Scoter, it was made into a skin and deposited in the collection of the Illinois Natural History Survey.

RUDDY TURNSTONE, *Arenaria interpres morinella*.—While this species is a regular, though uncommon, migrant along the shores of Lake Michigan, little is known of its occurrence elsewhere in Illinois. On May 18, 1939, I observed three Ruddy Turnstones on a sand levee of the Lake Chautauqua National Wildlife Refuge, near Havana, Illinois. I saw seven individuals in the same vicinity on May 27, 1939. No other records of this species are known for the Illinois River Valley.

WESTERN WILLET, *Catoptrophorus s. inornatus*.—Regarded as a rare migrant by Ford, Sanborn and Coursen in 'Birds of the Chicago Region,' this bird is given only fall-migration dates by them. The writer saw two Western Willets on the Lake Chautauqua National Wildlife Refuge, May 18, 1939.

AMERICAN KNOT, *Calidris canutus rufus*.—An uncommon migrant along Lake Michigan, this shorebird is rare inland. Since there are no known records of its occurrence in the Illinois River Valley, it is felt worthwhile to record that I observed a single individual in partial nuptial plumage on August 11, 1939, at Duck Island, Banner, Illinois. It was seen with an 8×40 binocular at a range of ten yards.

LEAST TERN, *Sterna antillarum antillarum*.—While there are scattered records of this tern along the Mississippi River as far north as Quincy, no recent records exist for the Illinois River. Arthur S. Hawkins and the writer saw several individuals about Flat Lake near Brussels, Illinois, about July 16, 1938.—FRANK C. BELLROSE, *Illinois Natural History Survey, Urbana, Illinois*.

Rare water- and shorebirds in north-central Oklahoma.—The recent large-scale program of building artificial lakes and ponds in the Plains States has made conditions more favorable for waterbirds of all types. The following records for 1939 and 1940 from the vicinity of Stillwater in Payne County, Oklahoma, indicate that certain species may be swinging east of their normal migration routes or stopping more frequently in this area on account of the new habitats.

WATER-TURKEY, *Anhinga anhinga*.—Two seen in a patch of drowned trees in Lake Carl Blackwell on July 29, 1940. Mrs. Nice (1931) lists one record for Murray County in the south-central part of the State. A nesting colony in McCurtain County in the southeast corner of Oklahoma has recently been reported by Nice (1938).

WHITE-FACED GLOSSY IBIS, *Plegadis guarauna*.—Two seen at Boomer Lake on April 20, 1939; one seen in a fish pond below the Lake Carl Blackwell dam on June 5, 1940. Nice (1931) lists one record for central Oklahoma. Semple and Sutton (1938) took two specimens in Beaver County in extreme northwestern Oklahoma, in 1937.

PIPING PLOVER, *Charadrius melodus*.—Three seen at Lake Carl Blackwell on May 15, 1940. As far as can be ascertained, this is the first record for this species in Oklahoma. These birds were under observation for more than half an hour as they fed on a mudflat less than one hundred feet away. Semipalmated Plovers were present for comparison and the differences in coloration were very conspicuous. The orange-yellow area at the base of the bill and the prominent collar readily separate this species from the Cuban Snowy Plover that nests on the salt plains and has been recorded in migration in the eastern part of the State.

BLACK-BELLIED PLOVER, *Squatarola squatarola*.—One seen at Boomer Lake on May 21, 1939; twenty-three seen in two flocks at Lake Carl Blackwell on May 15; two seen and one, a male, collected at Lake Carl Blackwell on September 27, 1940. Nice (1931) lists one sight record but no specimens. Semple and Sutton (1938) saw a flock of about thirty Black-bellied Plovers in Beaver County.

RUDDY TURNSTONE, *Arenaria interpres morinella*.—Three seen at Boomer Lake on May 28, 1939; one seen at Lake Carl Blackwell on May 15, 1940. Apparently these are the first published records for this species in Oklahoma. Mrs. Nice informs me that she has two unpublished records.

LONG-BILLED CURLEW, *Numenius americanus americanus*.—One seen at Boomer Lake on April 15, 1939; one seen at the same location on May 21, 1939; a single bird seen at Lake Carl Blackwell on March 27, 1940; another in the same area on May 22, 1940. Nice (1931) lists only one record for central Oklahoma.

HUDSONIAN CURLEW, *Phaeopus hudsonicus*.—Three seen at Lake Carl Blackwell on May 13, 1940. These birds were observed for some time resting on a mudflat. With an eight-power binocular at 150 feet the light median crown-stripe bordered by dark lateral crown-stripes was very conspicuous. Semple and Sutton (1938) collected the only specimens known from the State in Beaver County in 1937.

WILLET, *Catoptrophorus semipalmatus* subsp.—A flock of thirteen Willets was seen at Lake Carl Blackwell on May 21; four seen in the same area on May 22, 1939; three seen at Boomer Lake on April 26, 1940; a single bird seen at Lake Carl Blackwell on May 10, 1940. Nice (1931) lists five records for the State. One of these was a specimen taken near Stillwater by G. A. Moore (1928). Karl W. Haller (Sutton, 1938) took a specimen of *Catoptrophorus semipalmatus inornatus* in Beaver County in northwestern Oklahoma.

DOWITCHER, *Limnodromus griseus* subsp.—A flock of four seen at Lake Carl Blackwell on November 14, 1939; one seen in the fish ponds at Lake Carl Blackwell on May 15, 1940; one seen at Boomer Lake on May 8, 1940; a flock of five seen at Lake Carl Blackwell on May 12 and May 15; one seen at Lake Carl Blackwell on July 29; six seen in the same area on October 20. Nice (1931) has three records for Oklahoma. Stevenson (1936) saw a single dowitcher at Crystal Lake in Woodward County on April 29, 1935; also three birds on the west shore of Lake Overholser, Canadian County, on October 6, 1935. Sutton (1938) collected specimens of both subspecies in Beaver County, and observed a single bird in Comanche County in southwestern Oklahoma, in 1937.

STILT SANDPIPER, *Micropalama himantopus*.—One seen at Boomer Lake on May 28, 1939; flocks ranging from four to twenty-seven birds seen at Lake Carl Blackwell during the period from May 15 to May 21, 1940. Nice (1931) lists five records from central and western Oklahoma. Sutton (1936) records a specimen from Ellis County near the western boundary of the State. Sutton (1938) records three specimens taken in Beaver County. Nice (in correspondence) believes that this species is now a regular transient in the western half of the State.

MARBLED GODWIT, *Limosa fedoa*.—A flock of eight seen at Lake Carl Blackwell on May 12, 1940. Nice (1931) lists one record from the western part of the State.

HUDSONIAN GODWIT, *Limosa haemastica*.—Three seen at Boomer Lake on April 20, 1939; one seen at Lake Carl Blackwell on May 15, 1940. Nice (1931) lists three records including two specimens from Payne County taken by Moore.

CASPIAN TERN, *Hydroprogne caspia imperator*.—A flock of eight seen at Lake Carl Blackwell on September 23, 1940. Nice (1931) lists one record for the State. Stevenson (1936) reported seeing a large tern, probably of this species, over Lake Spavinaw, Mayes County, on September 20, 1935.

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—A. M. BAUMGARTNER AND F. M. BAUMGARTNER, *Oklahoma A. & M. College, Stillwater, Oklahoma.*

Hudsonian Curlew in District of Columbia.—On May 18, 1941, at about 2 p. m. E.S.T., we were looking for birds, as part of an all-day 'Century Run' (eventual total within the District of Columbia, 91), along the Potomac River and its western shore line from the road running around the new airport under construction at Gravelly Point, D. C. When we were at the most northeasterly portion of this road, i. e., that part farthest out in the river and nearest the City of Washington, we observed a mixed flock of three Black-bellied Plovers and four Hudsonian Curlews (*Phaeopus hudsonicus*) flying at an altitude of about 500 feet (*cf.* Washington Monument) from the east toward us and the airport; when half-way across the Potomac they turned (perhaps they were then able to ascertain that the airport was not a mudflat) at right angles toward the city and flew north over the buildings of the Department of Agriculture and disappeared in the haze over the city. The white forehead and black belly on the plover and the all-dark body and longer, slightly down-curved bill of the curlew were clearly visible. Although the Black-belly has been recorded with some regularity in the District of Columbia this apparently represents one of the very few records here of the Hudsonian Curlew.—HENRY H. COLLINS, JR., *3116 Rodman St., N. W.*, AND JOHN S. WEBB, *U. S. National Museum, Washington, D. C.*

Ruff in Massachusetts.—On July 30, 1940, in a marsh-pool close to the highway that skirts Newburyport harbor, the tide had begun to ebb and many shorebirds had congregated—among them a large one that I noticed with swiftly mounting excitement was none of those I knew. It was running about, among many Lesser Yellow-legs, where the water was still two or three inches deep. It stood as tall as they, on legs of a green-gray color, very pale, and it was decidedly heavier, more robust, than they, and bellicose when they came near it. Its bill was about the same length as theirs, dark, and slightly decurved, like a Pectoral Sandpiper's. Its feathers looked ruffled, very dark-mottled in front and on the whole head but shining white on the rear under parts and—as, presently, it bathed and preened—on the wing-linings. Then it took several short, circling flights, displaying more white in the upper surface of the wing and—most satisfactorily—two oval patches of white on either side of the narrowly dark central tail-coverts. This, I knew, clinched the identification, but I drove later in the day to Salem and saw the Peabody Museum's specimens of *Philomachus pugnax*, ascertaining that as my bird had no whitish throat nor breast-spots, it must be a ruff-less male Ruff.

My mind then flashed back to May 14, 1934, when at a marsh-pool in Hadley, Massachusetts, I had studied a similar bird but missed the oval croup-patches; the tail had looked, in flight away from me, like those of the accompanying Yellow-legs, a Greater and two Lesser. That bird had yellowish-green legs and a less robust body, but its fore-parts had been similarly dark—in fact, darker and decidedly ruddier, without any light color save a tiny spot at the mouth which was exactly matched by the Newburyport bird. My wise friend and counselor, Ludlow Griscom, had commented on my description of this puzzler: "Either a male Ruff in the erythristic phase, or a Curlew Sandpiper." The latter was impossible, because of its shorter legs and markedly down-curved bill, but the Ruff had only *seemed*

impossible because I supposed it would be rather the size of the Greater than the Lesser Yellow-legs, with a thick-based, dagger-shaped, probably yellow bill and (on May 14) ruffs. So I wrote pages 240–241 in 'Birds of the Connecticut Valley in Massachusetts' on the supposition that I must have seen an erythristic Stilt Sandpiper! I am now perfectly certain that it was a Ruff. We live and learn.—SAMUEL A. ELIOT, JR., *Smith College, Northampton, Massachusetts.*

Glaucous Gull in Florida.—On April 2, 1941, while examining a large group of gulls at North Miami Beach, Florida, the writers noticed among the others, a large white gull, which proved to be a Glaucous Gull (*Larus hyperboreus*) in second-year plumage. The bird was a particularly white individual, being nearly snow white all over. The legs were pink, and the bill was basally light, the terminal one-third dark. The eye was completely dark. The darkness of the eye and of the tip of the bill would seem to eliminate the possibility of confusion with an albino of another species. An unexcelled size comparison was afforded by six immature and one adult Herring Gulls (*Larus argentatus smithsonianus*) which were standing with the Glaucous Gull in the mixed flock of Herring and Ring-billed Gulls (*Larus delawarensis*). The Glaucous Gull was markedly larger than the Herring Gulls, and had a decidedly larger bill than a Herring Gull which conveniently walked over and stood immediately next to the Glaucous Gull.

The flock was sufficiently tame to permit us to approach to within about one hundred feet to determine these points. Both writers are familiar with the Glaucous Gull as a regular winter visitor to the Northeast.

We are aware of two previous records of the occurrence of this species in Florida: Howell's 'Florida Bird Life' records a second-year bird seen by Eaton and Savage at Coronado Beach, February 23, 1930; Weston (Auk, 53: 445, 1936) records a second-year bird at Pensacola Bay, March 14 to May 10, 1936.—HUSTACE H. POOR, *112 Park Ave., Yonkers, New York,* AND OLIVER K. SCOTT, *767 Central St., Framingham, Massachusetts.*

Gulls eat fruit of the cabbage palmetto.—In the early forenoon of February 5, 1941, while 'birding' along the Indian River, Vero Beach, Florida, I saw several Ring-billed Gulls (*Larus delawarensis*) hovering above the crown of a cabbage palmetto. One by one, with supreme grace, the birds fluttered down to the pendant fruit stalk, snatched a berry, then sailed off. This was repeated several times, while in a nearby palm an immature Herring Gull (*Larus argentatus smithsonianus*) was clumsily perched on a fruit stalk and eating the berries. Two days later I observed forty or fifty gulls of both species devouring the fruit.

Two boatmen (natives) to whom I remarked about this behavior, said that the gulls had been observed feeding on the palmetto drupes for four or five days previously, and that never before had the gulls been seen to do this.

Raw northerly winds and chill temperatures prevailed in Florida during early February, and the gulls evidently had a difficult time securing their normal food. The drupes of this tree are exceedingly hard, and as palatable, from the human standpoint, as cherry-stones.—MAURICE BROUN, *Hawk Mountain Sanctuary, Route 1, Orwigsburg, Pennsylvania.*

Common Terns nesting on muskrat houses.—The following notes concern an unusual marsh colony of Common Terns, *Sterna hirundo,* of which all the nests were located on the tops of muskrat houses.

The marsh where the observations were made had been formed in 1929 when

low farming land, bordered on one side by the Thames River and by Lake St. Clair on the other, was flooded. The area is now covered by a dense growth of aquatic vegetation, and it supports a large population of muskrats.

On finding the nests on the muskrat houses, the writer took them to be those of the Forster's Tern, *Sterna forsteri,* which had been reported from that region by various authors. Examination of the fledglings and closer scrutiny of the adults disclosed that the colony was composed probably entirely of Common Terns. One downy young and one female were collected from a nest. No individuals of the related species were found.

Approximately three-thousand muskrat houses were on the marsh and it was estimated that of these, 100 to 150 were used as nesting sites by the terns. The nests were not confined to one spot, but were distributed well over the area of the marsh. Seventy-five nests were examined, and several were kept under continuous observation. The terns did not choose between used and abandoned houses, but no nests were constructed on houses which were so worn down with age as to extend less than a foot above the surface of the water. One nest was located on top of a 'push-up' which had been built by muskrats on top of an old barrel, so that the nest was about four feet above the water. While the nests were sometimes found on adjacent houses, there was no house that supported more than one nest. Roberts (1932) reports that Forster's Tern will sometimes build four or five nests on the same house.

It is interesting to note that the nests of the terns were restricted to the comparatively new marsh, which indicates that the age of the colony was probably less than seven or eight years. The lake front, adjacent to the area described and separated from it by a narrow strip of land, was also marshy and supported a good number of muskrat houses. The houses of this marsh lacked nests, however, even though they were located nearer the lake, which was used by the terns as a feeding ground. Since the terns did not use the old marsh, it is possible that they had not used muskrat houses for their nests in that region until the flood in 1929.—OLIVER H. HEWITT, *Cornell University, Ithaca, New York.*

An egg of the Marbled Murrelet.—On May 23, 1934, near Mittelnach (an islet in the Strait of Georgia, just east of Campbell River, Vancouver Island), the senior author shot a female Marbled Murrelet, *Brachyramphus marmoratus,* from the oviduct of which was subsequently taken an unbroken, perfectly formed, well-marked egg. Though ledges, turf, and shrubbery on Mittelnach were thoroughly searched that day, no murrelet was flushed anywhere on the island itself.

The egg measures 58.5 × 39.5 mm. It is *pale glass green* spotted with *lavender gray* (light), *deep madder blue, sepia, bone brown,* and *black* (italicized words from Ridgway's 'Color Standards and Nomenclature,' 1912). From the photograph, herewith reproduced (Plate 19), it will be seen that the spots, rather than being evenly distributed, tend to encircle the larger end.

The senior author has published ('Birds in the Wilderness,' 1936: 167) an informal account of the taking of this specimen; but since descriptions of the Marbled Murrelet's egg continue to be based primarily upon the famous, though imperfect, George G. Cantwell specimen taken in the Prince of Wales Archipelago almost half a century ago (and figured on Plate 48 in Bent's 'Life Histories of North American Diving Birds,' 1919) it seems advisable to publish the present description with a natural-size photographic illustration.

The authors are indebted to W. E. Clyde Todd, Sydney Prentice, Ottmar F.

von Fuehrer and Mrs. Ruby Taylor Ruettger, of the Carnegie Museum (where the egg now is) for their assistance in measuring, photographing, and describing the specimen.—GEORGE MIKSCH SUTTON AND JOHN B. SEMPLE, *Cornell University, Ithaca, New York.*

Possible homosexual mating of the Rock Dove.—Although it is known that captive Domestic Pigeons sometimes mate homosexually, a search of available literature yields no record of feral ones doing so. One phenomenon of some such unions, however, is the assumption by each bird of both rôles in copulation ('The Posthumous Works of C. O. Whitman,' Carnegie Institution of Washington, 3: 34–35, 1919). The following two instances of reciprocal treading by feral birds may indicate, therefore, that these matings do occur in the Rock Dove state; it was impossible to collect the birds for positive interpretation of their behavior. The pigeons were members of a small flock that has lived wild, in a city neighborhood of detached homes, for seven years to the writer's knowledge; whether the individuals were the same on each occasion is not known.

April 21, 1938: Bird A walked around bird B for a turn or two, crouched, and was trod. That was repeated. Then B crouched and was mounted by A; however, A stepped right down again and itself crouched and was trod for a third time. B then crouched again, and A mounted and now performed, to every appearance, normal copulation.

August 24, 1940: A was treading B when the birds were first noticed. Upon dismounting, A walked a few steps and crouched, and B walked to it, mounted, and trod. B, after dismounting, in turn moved several steps away and crouched, and A again mounted and trod. There was no billing or wheeling between-times; the birds walked directly to each other. The second and third treadings seen appeared to be somewhat briefer than normal.—HERVEY BRACKBILL, *3201 Carlisle Ave., Baltimore, Maryland.*

Chimney Swift having benign lymphangioma.—On May 15, 1939, while trapping Chimney Swifts, *Chaetura pelagica,* with Mr. John B. Calhoun in Charlottesville, Virginia, I removed a bird from the gathering cage, that had a large prominence evident under the left side of its neck. The bird was taken to the laboratory, etherized and the tissue removed. The mass was approximately 2×1.5 cm. in diameter, attached to the skin at one small point, and moved about quite freely under the skin when manipulated. The specimen was preserved in Bouin's fixative and sent to Herbert R. Mills, M.D., Clinical Pathologist, in Tampa, Florida, for gross and microscopical examination. His report follows: "The tissue which we received from you a few days ago from the neck of a Chimney Swift, *Chaetura pelagica,* is an ovoid solid encapsulated nodule, measuring 2×1.5 cm. Microscopical sections show no evidence of malignancy. The sections are characterized by many small vascular-like spaces separated by a loose fibrous stroma. These spaces are lined with endothelial cells and are practically empty. Opinion: Benign lymphangioma."—J. C. DICKINSON, JR., *University of Florida, Gainesville, Florida.*

Boreal Flicker in Kansas.—The author became interested in the Boreal Flicker, *Colaptes auratus borealis* Ridgway (Proc. Biol. Soc. Washington, 24: 31, 1911; type locality, Nulato, lower Yukon River, Alaska), after reading a note by Alexander Wetmore (Auk, 57: 113, 1940), in which he states, "Recent studies have indicated to me that this race of flicker, though not recognized in the fourth edition of the A. O. U. 'Check-list,' is valid, with a breeding range extending from Labrador to

Alaska, south to northern Minnesota and eastern Montana, and in migration to the States to the south." The purpose of the study indicated in this paper was to determine whether or not that subspecies comes as far south as Kansas in its winter migration. Heretofore, only the Northern Flicker, *Colaptes auratus luteus*, and the Southern Flicker, *Colaptes auratus auratus*, have been recorded as occurring in Kansas, the former ranging over the entire State, and the latter being found only in the extreme southeastern part.

In this study, 139 flickers in the collection of the Museum of Birds and Mammals at the University of Kansas were examined. Among these were specimens taken at all seasons of the year. The measurements used are: length (where possible), wing, tail, culmen, and tarsus. All measurements except the length were taken personally by the author. The basis for the differentiation of the two subspecies, *Colaptes auratus luteus* Bangs and *Colaptes auratus borealis* Ridgway, is taken from Ridgway's 'Birds of North and Middle America' (Bull. U. S. Nat. Mus., no. 50: 18–20, 1914).

I am indebted to Mr. C. D. Bunker, Curator of Birds and Mammals, Museum of Birds and Mammals, University of Kansas, for allowing me free use of specimens under his care, and to Dr. Alexander Wetmore, for his helpful criticism of this work.

In Ridgway's (op. cit.) comparison of the two subspecies, *C. a. luteus* and *C. a. borealis*, he states that they are "similar in coloration." He gives the following measurements for *C. a. luteus:* adult males, length (skins), 250–293 (265) mm.; wing, 154–165 (156.3); tail, 96.5–112 (105.9); culmen, 31–40 (34.6); tarsus, 26.5–31 (28.1). Adult females, length (skins), 248–292 (259) mm.; wing, 149.5–159.5 (155); tail, 97–115 (103.9); culmen, 31–38.5 (33.8); tarsus, 26.5–29.5 (27.8). For *C. a. borealis:* adult males, length (skins), 270–314 (292) mm.; wing, 156–170 (162.9); tail, 102.5–115 (107); culmen, 34.5–40 (36.4); tarsus, 27–31.5 (29). Adult females, length (skins), 270–310 (287) mm.; wing, 156–171 (162.3); tail, 99–115 (105.5); culmen, 32.5–38.5 (35.6); tarsus, 27.5–30.5 (28.8).

With the progress of the examination of the specimens, all of which were catalogued as *C. a. luteus*, it became evident that certain individuals were too large to be considered as belonging to that subspecies, and that they came well within the limits of *C. a. borealis*. It is my opinion that these specimens are members of the latter subspecies. This is further indicated by the fact that all the specimens whose characters appear to be those of the Boreal Flicker were taken in the northern part of Kansas during the months from September to April, and should, therefore, be considered as migrants or as winter residents.

Twenty specimens were found that may be considered Boreal Flickers. The range of measurements of these is as follows: length, 290–315 mm.; wing, 160–166; tail, 108–124; culmen, 37–42; tarsus, 26–31. For comparison, the measurement range of twenty specimens of *C. a. luteus*, taken in the winter, and of twenty taken in the summer, is given: winter specimens, length, 285–303 mm.; wing, 149–159; tail, 107–117; culmen, 35–40; tarsus, 25–28. Summer specimens, length, 280–305 mm.; wing, 146–156; tail, 92–111; culmen, 33–39; tarsus, 26–29.—GEORGE C. RINKER, *Museum of Birds and Mammals, University of Kansas, Lawrence, Kansas.*

The passing of the Ivory-billed Woodpecker.—One of the mysteries of Nature that has puzzled me for many years is the passing of the Ivory-billed Woodpecker (*Campephilus principalis*), a bird once resident in most of the forests south of the Ohio River to the Gulf, and east of the Mississippi River to the Atlantic Ocean. This bird, although naturally shy of man, was endowed with a strong,

vigorous personality—far better able to cope with the advance of civilization than its lesser companion, the Pileated Woodpecker (*Ceophleus pileatus*); yet, the Pileated Woodpecker has survived in numbers, extended its range, and is in no danger of extermination, while the Ivory-bill has gradually disappeared, until now it is practically exterminated.

Two occurrences during my lifetime lead me to believe the passing of the Ivory-bill coincides with the cutting of the hardwood forests within its range. From my earliest childhood Ivory-bills were resident in the hardwood timber of Avery Island, and the great forest extending east from its hills to the Atchafalaya River. There is no forest west of Avery Island. The bird was well known to the French-speaking natives, who called it *Pique-bois grande* in differentiating it from the Pileated Woodpecker known as *Pique-bois noir*.

While Ivory-bills were never common at Avery Island, they were resident, and from three to seven pairs nested yearly in the hardwood areas where gray oak, white oak, magnolia, elm, red gum, and hickory were the principal trees. The lower lands between the ridges were timbered with cypress, tupelo gum, black gum, and maple. Timber-cutting began in the area along the lower Atchafalaya south of the Southern Pacific Railroad about 1900, and gradually worked west. All trees of commercial size and quality were cut. As the cutting of the forests progressed, ever moving from east to west, the shyer birds and mammals kept ahead of the cutters, moving west in the primeval forests.

By 1918, black bear and Ivory-bills were unusually plentiful in the forests of Avery Island, and in the twelve square miles of virgin forest east of the Island in which no cutting had been done up to that time. In 1918, the standing timber on this property was sold to one of the large saw-mills operating in southern Louisiana, and cutting began that year. In order to get the great logs out of the woods, to streams in which they could be rafted and floated to the mill, dredge-boats were sent into the woods to cut canals parallel to one another, 2,000 feet apart. The trees were then cut down, logged, and large floating flat-boats were used as pull-boats to pull the logs with long wire cables out to the newly cut canals. The destruction of this forest and the noise of getting out the timber drove the bear, Ivory-bills and other shy forest-dwellers completely away from this section. In 1920, a careful search located only three of these birds; one pair nested in a large deadened cypress that had not been cut. In 1921, the same pair nested in the same cypress a little lower than the nest of the year previous. A single bird was seen in 1923,—none since.

The Ivory-bills passed from the Avery Island territory with the cutting of the forest. Those of us in Louisiana, who care for and take interest in wildlife, have known for many years of a small number of Ivory-bills inhabiting a tract of some 80,000 acres of virgin timber known as the Singer tract in Madison Parish in the northeast part of the State, and in 1925 induced the Department of Conservation of the State to secure a protective right over the wildlife of this last great primeval forest within the State's borders, and to police it properly against wildlife destruction. The owners, however, reserved the right to develop their property whenever they wished, or to sell it. The colony of Ivory-bills remained undisturbed, except for occasional poachers, who killed them for their skins. In 1937, the owners sold the timber standing on 40,000 acres of their land, and cutting began at once. The timber on the rest of the land is for sale, and will probably be cut within a few years.

During this past spring (1940), a careful check of this tract, now being cut over, failed to locate a single Ivory-bill, and only seven were seen in the remaining forest in which no cutting has yet started, and some of these were probably duplications. When cutting begins on this last stand of virgin timber in Louisiana, Ivory-billed Woodpeckers will disappear, and the demands of civilization will have exterminated one more famous creature through environmental changes. —E. A. McIlhenny, *Avery Island, Louisiana.*

Tree Swallows and highways.—Apropos of Mr. Toner's note with this title in 'The Auk' (58: 98, 1941) I can record a similar occurrence at Preston, Connecticut, on August 20, 1940. While driving through the outskirts of the town I noted many Tree Swallows (*Iridoprocne bicolor*) on the road. They rose reluctantly in front of the car. About ten (all young of the year) were found killed. A large flock was feeding on the ground in an adjacent harrowed field. About a mile farther on a similar concentration of dead birds was found.—Charles H. Blake, *Lincoln, Massachusetts.*

Brown Thrasher wintering in northern Illinois.—From the windows of our home in Winnetka, we, or one of us, saw a Brown Thrasher (*Toxostoma rufum*), in good weather and bad, on the following days: December 23, 25, 29, 1940; January 1, 12, 20 (other members of our family reported it on other days in January), February 4, 5, 6, 8, 9, 10, 12, 16, 20, 21, 23, 28, March 2, 8, 12, 17, 22, 23, 26, 28, 31, April 3, 8, 11, 14, 19 (several thrashers seen), 1941. On many of these days the bird was seen at our feeding station. Nutmeats and sunflower seed are all that were ever in the feeder. The bird was seen at the feeder when it contained only sunflower seed. One of our near neighbors informs us that he saw a thrasher several times during the winter where his cook fed the birds.

Ford, Sanborn and Coursen, in their 'Birds of the Chicago Region,' 1934, give a few winter records, but no evidence of winter residence.—Walter T. Fisher, Francis D. Fisher, *949 Fisher Lane, Winnetka, Illinois.*

***Hylocichla fuscescens salicicola* in Tamaulipas: a correction.**—In Mr. Burleigh's and my 'Birds observed on the 1938 Semple Expedition to Northeastern Mexico' (Louisiana State University Occ. Pap. Mus. Zool., no. 3: 38, 1931) the Willow Thrush is listed on the basis of a male specimen taken near Gomez Farias, Tamaulipas, on February 28. This is a mistake. The bird is a Russet-backed Thrush, *Hylocichla ustulata ustulata.* It is identifiable by its distinct, buffy eye-ring and *brownish* rather than gray sides and flanks. I am at a loss to account for the error, regret that it has occurred, and am grateful to my student, Mr. Allan R. Phillips, for calling it to my attention.—George Miksch Sutton, *Cornell University, Ithaca, New York.*

Starlings at a blackbird roost.—A very large blackbird roost was discovered several years ago and it seemed unusual enough to warrant description and comment. If the Starling continues to increase in numbers, perhaps such large roosts will become fairly common. McAtee (Auk, 43: 373, 1926) has already called attention to a number of blackbird roosts in the eastern United States.

About fifteen miles southeast of Lexington, Kentucky, U. S. Highway 25 crosses the Kentucky River at Clay's Ferry. At this scenic spot between Fayette and Madison Counties the river has cut through solid rock making a very narrow valley hedged in by rocky walls and slopes which mark the channel of long

ago. The river at this point makes an S-shaped meander, thus causing the rim of the gorge to wall in the little Clay's Ferry valley on all sides. On the east bank of the river in Madison County, immediately north of the proposed site of the new bridge, is an area of about three acres comparatively sheltered from winds and storms. Here the temperature is perhaps somewhat higher than in the open during the colder days and nights. Fairly large and closely planted deciduous trees line the bank, and smaller trees, including some cedars, cover the more gentle slope which extends for about a hundred and twenty-five yards from the river bank to the highway. A large number of blackbirds chose to roost in this sheltered spot, which is less than a hundred feet above the normal water level in the narrow gorge and perhaps one hundred feet below the level of the surrounding Lexington peneplain.

Intensive observations were made at the roost this year (1941) during the month of March. On fair evenings the birds began to appear in the trees along the top of the gorge at about six o'clock. They seemed to converge in small flocks from all directions during the next half-hour. The smaller flocks aggregated into larger ones, but did not descend to the roost until about dusk, probably because the inhabitants of the valley in attempting to break up the roost, shot into the flocks frequently. The skillful maneuvering by the close formations of these large flocks as they veered sharply first in one direction and then in another while flying around before settling was an impressive sight not easily forgotten by any observer. When the birds settled, the trees appeared, from a few hundred yards distant, as though in full leaf. The small grove in which the birds settled did not exceed four acres, but the birds were so numerous that many limbs of the trees were broken and dung in places was four inches deep. It was impossible to estimate accurately the total number of blackbirds. Local ornithologists set the figure at anywhere from a half to around several million. The roost was probably populated by migrating flocks as well as by local birds within a radius of fifteen miles, since in travelling to the place we passed small flocks of blackbirds ten to fifteen miles away from and flying in the direction of the river gorge.

Of the three species seen at the roost, Starlings (*Sturnus vulgaris vulgaris*) were by far preponderant, outnumbering Bronzed Grackles (*Quiscalus quiscula aeneus*) at least twenty-five to one. A number of Cowbirds (*Molothrus ater ater*) were there during early March, but few were seen late in the month.

Residents of the valley told us that blackbirds had roosted there for the last seven years and that very large flocks regularly congregate each fall and spring. This was the first time, however, that the birds had remained all winter, which may have been due to the mildness of the weather. Observations from week to week indicated that the population of the roost was decreasing from its maximum. By early spring and summer, of course, the flocks are mostly dispersed. Although large flocks of Starlings were still there on March 27 and 28, on the 29th the birds no longer returned at night. Continued shooting into the flocks, coupled with seasonal impulses, probably caused the birds to leave suddenly. Three weeks of observation after March 29 indicated that no birds returned at dusk.

Collecting was done on March 21, 22, 27 and 28 by firing a shotgun into the roost in a number of places. A few grackles were taken, but the proportionate number was very small. Of 285 Starlings, 129 were males and 156 females, a ratio of one male to 1.2 females. The ratio of male to female birds in this

rather small sample is lower than that reported by Hicks (Bird-banding, 5: 103–118, 1934), and by Odum and Pitelka (Auk, 56: 451–455, 1939), who stated that male Starlings exceeded females by almost two to one in birds taken at roosts.

It is interesting to compare sex ratios of Starlings with the secondary sex ratios of other birds, especially those established from banding records by McIlhenny (Auk, 57: 85–93, 1940). Among wild ducks, for example, the males usually outnumber females by anywhere from one up to three or more. The Mallard (*Anas platyrhynchos platyrhynchos*) is exceptional, however, since there are about equal numbers of males and females. Trapping records reveal that males are 1.9 times as abundant as female Cardinals (*Richmondena cardinalis cardinalis*). The preponderance of males to females of the Cowbird (*Molothrus ater ater*) is 2.82 to one. The greatest sex variation reported by McIlhenny is for the Gulf Coast Red-wing (*Agelaius phoeniceus littoralis*), in which he states there are 5.43 males to each female. Only in the Boat-tailed Grackle (*Cassidix mexicanus*) do females outnumber males by two to one.—JOHN B. LOEFER, *Berea College, Berea, Kentucky,* AND J. A. PATTEN, *University of Kentucky, Louisville, Kentucky.*

Myology of *Fregilupus varius* in relation to its systematic position.—*Fregilupus varius* was a starling that inhabited the island of Réunion and became extinct there about the middle of the last century. The last specimen was taken on Réunion in 1835 and two were taken on Mauritius in 1837 (Rothschild). The cause of its extinction is not certainly known, but it may have been due to the killing of the birds by natives when the birds were feeding on the coffee berries of the numerous coffee plantations or they may have succumbed in competition with introduced Indian Mynahs (Renshaw, Zoologist, (4) 9: 418, 1905).

Buffon was the first to describe the bird and in doing so he placed it among the Upupidae. Boddaert later named it *Upupa varia*. The bird had a crest which endowed it with a hoopoe-like appearance. However, the investigations of later workers, Levaillant, Vieillot, Hartlaub, and Schlegel, determined from external characteristics alone that this bird was a starling (Murie).

Murie (Proc. Zool. Soc. London, p. 474, 1874) made a study of the skeleton of *Fregilupus varius* from which he concluded that on the basis of its osteological characteristics, the bird was a starling closely related to the genera *Pastor, Sturnus,* and *Gracula*. He states further that the osteology does not relate it to the hoopoes, the fregiline section of the crows, nor to the bee-eaters or the paradise birds. In the 'Catalogue of the Birds in the British Museum' (vol. 13, 1890), *Fregilupus* is listed as one of 41 genera of the subfamily Sturninae. Rothschild ('Extinct Birds,' 1907) lists eighteen known specimens of *Fregilupus varius*.

A direct comparison was made between a preserved specimen of *Fregilupus varius* in the Museum of Comparative Zoology and *Sturnus vulgaris*. The dissection of the former was done so that the specimen is still intact, a separation of the muscles being sufficient to determine their gross morphology. Unfortunately, both legs had been cut off at the knees and both fore limbs at the elbows in making it into a study skin, hence a comparison of only the thigh, femoral, shoulder, and humeral muscles was possible. The muscles of this specimen after having been in alcohol for one hundred years have been considerably shrunken and consequently a comparison of muscle size between *Fregilupus* and *Sturnus* was impossible. The only warranted comparison was of the gross morphology of the muscles.

A study of the muscles in this specimen of *Fregilupus varius* revealed an almost

exact similarity in form to those of the pelvic and pectoral girdles and the syrinx of *Sturnus vulgaris*.

From a taxonomic standpoint, the myological similarity of *Fregilupus varius* to *Sturnus vulgaris* does not necessarily indicate that *Fregilupus varius* is a starling, as the myological differences existing between such forms as *Sturnus* and *Corvus* are so slight that the myology alone is not sufficient to differentiate between such forms.

From a myological examination alone, then, there is nothing to indicate that *Fregilupus varius* is or is not a member of the family Sturnidae. However, such close myological similarity, together with the osteological and external structural evidence, serves to indicate that *Fregilupus varius* is in all probability a member of the subfamily Sturninae.—MALCOLM R. MILLER, *10630 Wilkins Ave., West Los Angeles, California.*

Predation of Boat-tailed Grackles on feeding Glossy Ibises.—For the past five years the writer has had considerable experience with the only concentration of Eastern Glossy Ibis (*Plegadis f. falcinellus*) which occurs in this country, viz., certain of the 'reefs' and shoreline of Lake Okeechobee, Florida. Extensive investigations have been made of the bird in both its rookeries and its feeding grounds. The conduction of the Audubon Wildlife Tours in the Okeechobee region in 1940 and 1941 has resulted in dozens of trips by station-wagon, along the road which skirts the northern shore of the lake, and not one of these has failed to exhibit feeding groups of these ibis during the months of February and March. During the winter of 1941, while conducting these trips, the writer noted an occurrence which had hitherto escaped him completely, and apparently has not been noted by others. This has to do with the frequent predation by the inland form of the Boat-tailed Grackle (Weston's Grackle, *Cassidix mexicanus westoni*) on feeding Glossy Ibis. It was noted on at least five different occasions this past winter (February and March) and appears to deserve some comment.

The ibis of this region feed very largely on crayfish, which they secure by probing the holes made by these creatures. Flocks of as many as three to five hundred birds may be watched within a few yards to one hundred and more, from the roadside. More often than not, Snowy Herons are mixed with the feeding ibis, and, as noted this season, many of the grackles. These latter would swarm about the ibis, and no sooner would one of the latter seize a crayfish, than it would immediately tower into the air with it, only to be instantly beset by from one to three or four grackles. A series of aërial gyrations would follow, with the almost inevitable result of the ibis losing the crayfish to one of its sable tormentors. Sometimes, these battles would take place a few feet above ground, sometimes as much as fifty, sixty or a hundred, but only in the rarest instances did the ibis succeed in getting away with its catch!

On one occasion, with a station-wagon full of observers, a full half-hour was spent in watching this performance. Scores of ibis secured crayfish and rose into the air, but only on five occasions, did the grackles fail literally to take the creature out of an ibis's bill. The picture presented was a unique one. In unobstructed short marsh grass, was a black and white blanket-like mass of feeding ibises and Snowy Egrets, with smaller black attendants (grackles). Every now and then, a black form would shoot into the air, instantly followed by several smaller black forms. It looked like huge flakes of black corn popping over an invisible fire. Up they would go, down they would come, while another would spring

up almost at once, with ascending and descending birds in the air constantly. Such a scene was presented off and on during the entire two months.

It would seem that the ibises could easily have swallowed their catch on the ground, but they would apparently always leap upward as soon as they withdrew the crayfish, and this was the signal for the grackles to attack. That the latter were highly successful was evident. It seems strange that this habit has not been noted before in many investigation trips in that area, and it is too much to suppose that it is of immediately recent development. One of the writer's visitors suggested that here was a factor in the general rarity of this species.—ALEXANDER SPRUNT, JR., *National Audubon Soc., Charleston, South Carolina.*

Birds imprisoned by a snowstorm.—An unusually severe and unseasonal snowstorm swept across the north-central States on November 11, 1940, to terminate a mild fall season. The storm commenced with a drizzling rain which changed in turn to sleet and snow with the falling temperature which reached a minimum of 10° F. during the night. The 42-mile wind accompanying the snow produced a blinding blizzard. Wildlife in general suffered a heavy mortality in many sections of the State.

Near the town of St. Peter, Nicollet County, Minnesota, there are seven caves excavated in the sandstone bluffs along the Minnesota River. To escape the storm, many birds of different species resorted to one of these caves for shelter. During the course of the storm, the cave entrance was blocked by drifting snow, imprisoning the birds. Immediately following the storm, Mr. Charles Meyer, who operates the caves as a tourist attraction, removed the snow barrier; and, upon entering the cave was confronted by these many birds flying about excitedly in their confine. He stepped out and to one side of the cave and allowed the birds to escape, attempting to identify and count them as they left. He noted thirteen Ring-necked Pheasants, nearly two dozen Bob-white, three Cardinals, two Robins, a number of Chickadees, several Downy Woodpeckers, and what he called "small woodpeckers" which may well have been White-breasted Nuthatches which were common in the vicinity.

The aggregate of different species in one cave would lead one to believe that the birds were thoroughly familiar with the cave and its protective potentialities. —G. N. RYSGAARD, *Minnesota Museum of Natural History, Minneapolis, Minnesota.*

A noteworthy concentration of birds.—The responses which animals sometimes make to conditions or situations affecting their well-being are sometimes striking, occasionally abrupt and frequently transitory. Recently I encountered such a response as represented by the group-feeding of several species of birds. The celerity of the response, the degree of participation therein and the sudden cessation thereof by these birds in the locality concerned was so conspicuous that the facts pertaining thereto may well be made a matter of record.

About 4.00 p. m. on March 14, 1941, while looking for early-spring birds some fifteen miles northeast of Albany, New York, I noted a conspicuous dark-colored patch on a nearby, open, snow-covered hillside. Inspection at closer range indicated that earlier the same day, several loads of stable manure had been thickly distributed over an area approximately 30 feet wide by 250 feet long. Detailed examination with binoculars revealed the presence of a considerable assemblage of birds that had been attracted to this place on account of food, principally in the way of waste grain, thus suddenly rendered available in a region still covered with

an average of six to eight inches of snow. A strong northwest wind was blowing and it was possible to approach within a few feet of most of the birds as I walked slowly from one end of the manured area to the other. The seven species present and my combined counts and estimates of the number of each follow: Ring-necked Pheasant (*Phasianus colchicus torquatus*), 1 ♂; Northern Horned Lark (*Otocoris a. alpestris*), 100±; Prairie Horned Lark (*Otocoris alpestris praticola*), 20±; Eastern Meadowlark (*Sturnella magna magna*), 4; Eastern Red-wing (*Agelaius p. phoeniceus*), 2 ♂'s and 1 ♀; Lapland Longspur (*Calcarius l. lapponicus*), 3; Eastern Snow Bunting (*Plectrophenax n. nivalis*), 150+.

Seldom is it possible in this territory to see at one time, on such a small area so many individuals of so many species of birds. The early local spring occurrence of the Eastern Meadowlark and the Eastern Red-wing, particularly the female, also is noteworthy.

The temperature at the time of my observations was 35 degrees Fahrenheit, with a maximum of 37 and a minimum of 18 degrees for the day. Maximal and minimal temperatures for the five preceding days had been close to these ranges. Precipitation had not occurred during the 36 hours immediately preceding these observations. However, between March 7 and 12, inclusive, a little more than 17 inches of snow had fallen. As a consequence, most of the food that was available on the ground for the bird species indicated was completely covered and had remained so despite some reduction in the amount of snow through melting.

For most of the weeks preceding the series of snowstorms, the ground had been largely bare and the available food supply for birds exposed. As a consequence, such ordinarily gregarious species as Horned Larks, Snow Buntings and Longspurs had been more or less generally dispersed throughout the local territory. But, with a heavy snowfall distributed over five successive days, that food supply was no longer accessible. Probably in their food-searching wanderings the birds were first attracted to the manured area by its dark appearance against the expansive white background. Having stopped to investigate, they found both food and shelter; and, by accretions from similar exploring groups or individuals the assemblage grew until it attained the unusual proportions just described.

A visit to the same spot the next day revealed a much diminished bird population on the area now considerably increased in size by the further distribution of manure. On this occasion the temperature was 42 degrees Fahrenheit, with maximum for the preceding 24 hours, 45 degrees, minimum 24 degrees. The snow on many of the exposed slopes had now melted, again revealing expansive though still restricted feeding areas. Evidently the diminution in the bird population on the fertilized tract had been associated in turn with the birds' response to the now more generally available food supply.—DAYTON STONER, *New York State Museum, Albany, New York.*

Banded birds recovered in El Salvador.—Three records of birds banded in the United States and recovered in El Salvador have recently been received and seem of sufficient importance to warrant immediate publication.

DUCK HAWK, *Falco peregrinus anatum*.—Duck Hawk 38-646340, an immature female banded September 27, 1940, at Cedar Grove, Wisconsin, by Owen J. Gromme, was shot January 21, 1941, at Acajutla, El Salvador. This seems to be the first specimen taken in the country and it is interesting that it was at the same locality as the bird recorded by Salvin in the 'Biologia Centrali-Americana.'

HERRING GULL, *Larus argentatus smithsonianus*.—A young bird (37-658725) banded July 4, 1940, at Penikese Island, Massachusetts, by Laurence B. Fletcher was "caught" at La Libertad, El Salvador, on January 27, 1941. This is apparently the first record for the species in El Salvador.

EASTERN WHITE-WINGED DOVE, *Melopelia asiatica asiatica*.—During the summer of 1940, Dr. George B. Saunders banded nearly eight hundred nestling White-winged Doves in the Rio Grande valley in Texas. Dove 40-419215, banded near Mission, July 31, 1940, was killed near San Salvador, El Salvador, October 15, 1940. According to the account of this species given by Dickey and Van Rossem ('The Birds of El Salvador,' Field Museum of Natural History, 1938), this recovery constitutes the first definite proof that some of the White-winged Doves of El Salvador are migratory.—MAY THACHER COOKE, *U. S. Fish and Wildlife Service, Washington, D. C.*

Ticks affecting birds' eyesight.—One afternoon in November 1936, as I stood under an oak-tree in my garden, a Slate-colored Junco fluttered to my head, thence to my shoulder, and then made an uncertain way along my arm. This was not a tame bird, but a nearly blind bird that could not distinguish between person and tree. Its misfortune was plainly due to the huge tick that was fastened just below the right eye, and that flopped and swung with every turn of the head. In March 1940, I saw another Slate-colored Junco (*Junco hyemalis hyemalis*) nearly blinded by a large tick below the left eye. This bird hopped and fluttered through a long flower border, saw well enough to keep just beyond my reach, but was loath to fly. Both these birds were easy prey for predators, and if they escaped quick killing must eventually have lost all vision and died of starvation.

In my four years of banding (starting February, 1937) I have trapped an even score of birds carrying ticks, and in every case I removed the parasites. Only a few of these birds were re-captured, but from their records it seems safe to conclude that if a tick is removed before damage to the eye has progressed too far, the bird recovers sight; and it seems equally reasonable to suppose that if the bird were allowed to retain the tick it would finally reach the condition of the juncos cited above. The ticks taken from two Slate-colored Juncos caught on January 29, 1941, were identified by Dr. H. E. Ewing, U. S. National Museum, Washington, D. C., as *Ixodes* sp. The tick family, Ixodidae, of which the dog tick is a type, has been regarded as a mammalian parasite, bird-infesting ticks belonging to the family Argasidae.

In every case but one, the ticks were very near an eye. The exception was Eastern Mockingbird (*Mimus polyglottos polyglottos*) no. 39-209852, banded October 30, 1939, who had claimed for his winter territory the area north of our house. When re-trapped January 5, 1940, he had a slight puffiness above the right eye, but I could see no cause for trouble. Bitter weather set in, the Mockingbird was regularly fed, and it was February 22 before he was again caught. Then his right eye was sunken and shriveled, and the cheek inflamed. Above the eye and back near the crown of the head (like an unnatural horn) was a medium-sized tick—roughly, about the size of a navy bean. Lifting the feathers, I found another tick, smaller, on the opposite side of the head, but it did not appear to have affected the left eye. I smeared both ticks with olive oil, and using small tweezers pulled them off, including the heads; and putting more oil on the inflamed areas, released the bird. The next day he moped, for once allowed smaller birds to eat at his tray. On the second day he was restored in

spirit, and was seen to charge into a flock of Cedar Waxwings raiding his holly berries. On March 7, just two weeks later, he was again trapped, and to my astonishment the eye was full, bright and normal in appearance. Soon after this, transient Mockingbirds began to move through, our resident no longer defended his territory, and presently disappeared. In late October 1940, he returned for a second winter in the north territory, on December 16 was trapped and identified as 39-209852. There was no indication of injury by the ticks of the preceding winter.

Slate-colored Junco no. 38-66899, banded November 23, 1939, was re-trapped December 1, 1939, with a tick (larger than the Mockingbird's) attached to the upper lid of the right eye. As I pulled the tick away, thick blood oozed from under the lid, spread over the eye. But on December 14, when re-trapped, this bird showed no trace of injury. Junco no. 40-39519 was not so fortunate. It was banded December 14, 1939, and re-caught December 30 with a tick on the lower lid of the left eye. A slight pull on the tick made blood come up over the eye, and a stronger pull tore the bird's skin at the corner of the eye, so I was forced to cut away the tick's body and leave the head embedded. When re-taken January 23, 1940, the bird was blind in the left eye. In both these cases, the ticks developed to noticeable size in a short time, in one instance in seven days and in the other sixteen days; in the case of the Mockingbird a month and a half elapsed between the first sign of eye irritation and the discovery of the ticks on top of the head. It is also noteworthy that despite the condition of the eye and cheek, the Mockingbird was vigorous and in good spirits, had sung in the mild weather of February, and had guarded his food shelf.

Of the other birds found to have ticks, only one has a record of re-capture. Junco no. 40-39513, banded December 5, 1939, was a return November 20, 1940. Repeating January 29, 1941, it had a small tick just below the right eye. On the tick's removal there was left the characteristic area—a bare reddish place, pitted in the center where the head was fastened. When the bird was re-taken February 5, this spot had entirely disappeared.

In four years I have banded 1,253 birds (which includes some nestlings), representing 28 species, and have found ticks on ten Slate-colored Juncos, five White-throated Sparrows (*Zonotrichia albicollis*), two Mockingbirds, and three Cardinals (*Richmondena cardinalis cardinalis*). The juncos are our commonest winter residents, and easily trapped.—Ruth Harris Thomas, *Route 3, North Little Rock, Arkansas.*

RECENT LITERATURE

Peterson's 'Field Guide to Western Birds'[1] is a counterpart of his well-known 'Guide' to eastern birds which has proved so successful a *vade mecum* for amateur as well as more experienced ornithologists in providing a ready means for identifying birds in the field. It follows the method adopted in the former volume, grouping side by side semi-diagrammatic colored figures of the various smaller land birds while the waterbirds, shorebirds, owls and hawks and some others are in black and white. Thus the main characters obvious in the field are brought out, rather than the more minute details of difference, while the accompanying text presents a brief supplementary description of each species, with a line or two concerning the voice and range. It covers the region west of the Rocky Mountains to the Pacific. Since the field discrimination of closely similar subspecies is not practicable, the difficulty is remedied by including at the back of the volume a chapter listing under each species, geographic races and breeding range. Finally there is a brief list of reference works and an index.

The author makes the pertinent suggestion that the vernacular names of some of the subspecies should be revised to include some hint of the racial affinity. Thus, while we have the San Diego Song Sparrow, the Rusty Song Sparrow, and other forms of the Song Sparrow, the several races of Steller's Jay as given in the A. O. U. 'Check-list' are called by such names as Black-headed Jay, Blue-fronted Jay, Coast Jay, which give no clue to the fact that all are likewise subspecifically related. Very likely appropriate book names could be suggested that would remedy this difficulty and aid the amateur who is apt to find Latin names somewhat beyond his mental horizon.

The book is of a convenient size to fit a capacious pocket, and in spite of the very small type of some of the chapters, is clearly printed. We predict for this handy volume a warm reception and a wide usefulness by all interested in the "sport of birding."—G. M. ALLEN.

'The Audubon Guide to Attracting Birds'.—Pertinently, the editor of this handbook[2] (for such it really is) asks at the outset, Why attract birds? He and his collaborators then proceed to answer this question and its consequent, How? For one very soon learns that bringing wild birds to one's dooryard may involve much more than strewing crumbs and confining the cat.

In the seven opening chapters, Mr. Roger T. Peterson sets forth concise and practical directions as to how, when and where to look for birds, useful hints in the sport of wildlife photography, tested methods of attracting birds by plantings for food and shelter. There are well-considered instructions for preparing various mixtures of artificial foods, making and placing proper nesting boxes, the importance of watering stations and the development of ponds for waterbirds. Mr. Richard Pough's clear statement of the 'balance of Nature' concept with its instructive diagrams will prove illuminating to many in pointing out the value of natural predators and the relation of reproduction rate to the population constant, with the pointed conclusion that the way to have more birds is not to

[1] Peterson, Roger Tory. A Field Guide to Western Birds. sm. 8vo, xviii + 240 pp., illustr., June 1941; Houghton Mifflin Co., Boston, Mass. Price $2.75.

[2] The Audubon Guide / to / Attracting Birds / Edited by / John H. Baker / Executive Director / National Audubon Society / 8vo, xviii + 268 pp., illustr., 1941; Doubleday, Doran and Co., Inc., Garden City, N. Y. Price $2.50.

eliminate natural enemies but to provide more food and shelter. Other chapters tell how a sanctuary for wildlife may be maintained and made to function as a valuable community center. Finally Mr. J. H. Baker sets forth an outline of the varied aims and endeavors of the National Audubon Society in its splendid work of conservation and popular education. An appendix presents in tabular form a list of trees, shrubs and vines recommended for different uses in planting and there is a list of useful references grouped under various heads.

The many practical hints and specific directions based on the combined experience of these and other investigators give this volume unusual value as an authoritative popular manual of the subject. Coming at a time when people turn more and more to the revivifying influence of association with birds it should prove of immediate helpfulness. (Parenthetically, we wish we might entirely agree with Mr. Baker that without birds, "trees, shrubs and vines would wither; crops would not thrive; . . . lawns would deteriorate; ponds and streams would become polluted, soils would erode.") The photographic illustrations and Peterson's handsome colored frontispiece of Great Blue Herons taking off are in keeping with the high standard set by this volume.—G. M. ALLEN.

Jørgensen and Blackburne's 'Glossarium Europae Avium.'—Ornithology shows us how many and varied types of related vertebrates may live in the same region yet get on together with a minimum of friction. This convenient glossary,[1] giving the Latin names of the usual birds of Europe, with their vernacular equivalents in some seventeen European languages, cannot fail, as Dr. E. Stresemann says in his Foreword, to prove of great value to newspapers, to bird-banders, to international organizations for bird protection, to ornithologists and other students, particularly those desiring to extend their ornithological knowledge beyond the confines of their political areas, but also it may prove a potent help toward furthering an "international understanding in the literal as well as in the higher acceptance of the term." In this understanding, men of science still lead the way. In all, 451 species are listed, with the polyglot equivalents. Separate indexes for the names in each language are given and there is a brief bibliography of works consulted. Miss Jørgensen is herself an accomplished linguist as well as an excellent amateur ornithologist, and with her collaborator makes acknowledgment to those in different countries who have aided in this unique undertaking. One may marvel at the spirit that makes possible in these times the production of such a work in Denmark.—G. M. ALLEN.

Miller on Speciation in the Genus *Junco*.—This elaborate monograph[2] on the juncos is intended less as a revision of the group than as a minute study of the evolution of the characters developed by the various populations. The method of approach is somewhat novel for instead of making deductions concerning the interrelationships of the component forms through a comparison of skins alone, as previous reviewers have done, Dr. Miller has carefully studied many of the forms in the field, has based his division into races upon series of breeding specimens, and emphasizes the fact that laboratory experiments, as in making crosses, imply unnatural conditions, since the natural environment in different parts of the wide range over which juncos occur, constitutes in itself a vast laboratory

[1] Jørgensen, Harriet I., and Blackburne, Cecil I. Glossarium Europae Avium. sm. 8vo, 192 pp., 1941; Ejnar Munksgaard, København.

[2] Miller, Alden H. 'Speciation in the Avian Genus *Junco*.' Univ. of California Publ. in Zool., 44 (no. 3): 173–434, 33 text-figs., May 24, 1941. Price $3.00.

wherein Nature herself is the experimenter. Thus, in the southern part of the range, in Mexico and Central America, sundry representative forms have restricted ranges as on islands or on mountain-tops, where resident populations have no opportunity for interbreeding with their nearest neighbors. Here the results of isolation may be studied, with the added factors of closer inbreeding and varying environment. Further, if such populations owe their present distribution to the effects of the Ice Age, as is usually assumed, it may be possible to measure approximately the amount of divergence taking place over a given period of time.

Farther north, as the range of the genus becomes less broken, the effects of diverse climatic conditions may be correlated with areal distribution. Again, there is evidence that certain races that have evolved in isolation from one another, may at length extend their ranges and come together again, with resulting hybridization rather than intergradation, if the characters concerned have become stabilized. The hybrids, thus resulting, are different from either parent. Apparently many cases could be brought together of western species or subspecies which have developed such distinctive characters that they hybridize rather than blend where ranges now overlap.

The feather pigments of juncos prove on analysis to be eumelanin, or granular black pigment, and phaeomelanin, a more oxidized type; in various dilutions the former gives the blacks and grays and the latter the browns, reds. and pinkish. These tints have characteristic distribution in areas of plumage (as pink sides) or may occur in special parts of the feather (as eumelanin peripherally in the barbules).

Considerable attention is given to the study of variation in coloration and in the amount of white present in the individual feathers of the tail as racial characters. In both these factors there is a considerable variation within the race or species that may be more or less characteristic of given populations. In the reviewer's experience, white markings (that is, unpigmented areas) in both birds and mammals, are seldom definite in extent, but show considerable variation. Other characters of juncos, including size and proportions, are also subjected to minute analysis. The author summarizes his systematic results by grouping the birds into two divisions, the yellow-eyed juncos of southern distribution in Guatemala north to the United States border, comprising the *alticola* and *phaeonotus* series ('Artenkreise'); and the dark-eyed juncos to the northward, comprising three 'Artenkreise,' the *caniceps* series, the *oreganus* series in the West and the *hyemalis* series in the East and North. In the case of the forms covered by the last edition of the 'Check-list,' the only changes in nomenclature suggested are: the association of *dorsalis* as a race of *J. caniceps* instead of being a race of *J. phaeonotus;* the reduction of *J. mearnsi* to a subspecies of *J. oreganus;* and the recognition of Dwight's *J. h. cismontanus* as a valid form. Altogether, the review presents a comprehensive survey of race formation such as we have for few other groups of North American birds.—G. M. Allen.

Hendricks's 'Field List of the Birds of Berkshire County' is intended for the use of local bird students, especially in connection with Peterson's 'Field Guide' within the covers of which it readily fits. It follows the plan devised by S. G. Emilio for a similar Essex County list, giving on the left-hand pages the names of birds likely to be met with in the field, followed in each case by symbols expressing their local status and by lines extending across the month-columns to denote graphically the times of appearance of each. The right-hand pages are ruled in spaces for brief field notes. Additional birds, for which there are but one or few records, are

given in a supplementary list, so that in all some 264 species are included. Neatly bound in stout paper covers it[1] forms in itself a convenient summary list of the birds of the county and is issued "with the hope that it will prove a challenge to extend our knowledge of the status of Berkshire birds."

To the increasing number of persons taking active interest in the local avifauna of this diversified portion of Massachusetts, it should prove a useful field companion.—G. M. ALLEN.

Sawyer on Making Bird Boxes.—In the ten years that have elapsed since the first edition of this guide appeared as 'Bulletin No. 1' of the Cranbrook Institute of Science, no less than 3500 copies have been sold, necessitating a second edition in 1938, and now a third edition,[2] brought up to date and enlarged. The text has been entirely rewritten and its scope has been widened to include allied western birds and four new illustrations have been added. Its directions for making simple but practicable nest boxes for hole-nesting birds from wren to Wood Duck, are brief but effective, with specific directions concerning what not to do as well as what should be done to make them suitable for desired tenants. Thus to be successful a nest box must be made not 'for birds' but for a particular kind of bird. There are also explicit directions for making attractive bird baths and feeding shelters from well-tested designs. All these are illustrated with artistic pen and ink drawings which help to make this a useful as well as intriguing guide in the art of encouraging the presence of familiar birds.—G. M. ALLEN.

Mack on the economic status of cormorants.[3]—In Australia shoots are organized for the persecution of cormorants and there is even a body of people in Melbourne whose purpose is the 'sport' of killing these birds. Much shooting is done at nesting colonies. Commercial fishermen at the Gippsland Lakes blamed depletion of the fisheries upon the cormorants. An investigation was made covering four species, the most important of which was the Large Black Cormorant (*Phalacrocorax carbo novae-hollandiae*). The information is presented by the volumetric method, which the author strongly endorses. The results are those usual in such cases but which 'practical' men apparently cannot foresee, namely, that the more abundant, hence more easily obtained non-commercial fishes greatly predominate in the food of the birds.

The decline in the fishery was due to the cutting of an inlet allowing diffusion of salt water into the formerly fresh lakes with consequent change in their entire ecology. The author well says, "There is only one way out and that is to seek to know intimately these natural conditions or laws, and to work with not against them."

The case reminds one of Stump Lake, North Dakota, where increasing alkalinity due to desiccation destroyed the fishes. Cormorants were persecuted as the cause even when the lake had become so alkaline that the only vertebrates left in it were mud-puppies (*Ambystoma tigrinum*) upon which the remaining birds were feeding.

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[1] Hendricks, G. Bartlett. Field List / of the / Birds / of Berkshire County / Massachusetts, 24 pp., 1941; published by the Berkshire Museum, Pittsfield, Mass.

[2] Sawyer, Edmund J. Bird Houses / Baths and Feeding Shelters / How to Make and Where to Place Them / Bull. Cranbrook Inst. Sci. (Bloomfield Hills, Mich.), no. 1, ed. 3, 40 pp., illustr., Dec. 1940. Price 20 cents.

[3] Mack, George. Cormorants and the Gippsland Lakes fishery. Mem. Nat. Mus. Australia, 12: 95–117, 15 figs., 1941.

Such misapprehensions and misguided actions convince one of the justice of Hamlet's sarcasm, "What a piece of work is man! how noble in reason! How infinite in faculty . . . in apprehension how like a god!"—W. L. McAtee.

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SMITH, K. D. Notes on the birds of Mashonaland, Southern Rhodesia. Ibis, (14) 5: 296–301, Apr. 1941.

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are forced to conclude that *Dryobates villosus audubonii* has not yet actually been taken in Oklahoma."

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TAVERNER, P. A. Another Scissor-tailed Flycatcher in Quebec. Canadian Field-nat., 55: 77–78, June 19, 1941.—A bird captured October 30, 1939, was found in a weakened condition within the town limits of Noranda.

TAYLOR, WILLIAM A. Moose Hill attracts many birds. Bull. Massachusetts Audubon Soc., 25: 109–116, June 1941.—With a briefly annotated list of the birds found at the Sanctuary.

THOMSON, A. LANDSBOROUGH. Report of the Bird-ringing Committee: progress for 1940. British Birds, 35: 9–14, June 3, 1941.—List of birds banded and numbers recovered.

TICEHURST, CLAUD B. Systematic notes on Indian birds.—X. Ibis, (14) 5: 318–319, Apr. 1941.—New are: *Trubura thoracica shanensis* from Maymyo, Upper Burma; and *T. luteoventris saturatus* from Chin Hills.

TIDBALL, JOHN. Winter bird census [in Minn.]. The Flicker (Minneapolis), 13: 15–17, 1941.

TRUMP, RICHARD F. Notable Nature hobbies. VI. The man of Avery Island. Nature Notes (Peoria, Ill.), 8: 140–142, May 1941.—E. A. McIlhenny's work in bird banding.

TUFTS, R. W. Late nesting of Red-eyed Vireo (*Vireo olivaceus*). Canadian Field-nat., 55: 78, June 19, 1941.—August 16, a nest with two eggs at Hazel Hill, Nova Scotia. Three young left Sept. 9.

TUTTRUP, JANE. Bird watching at Lake Koshkonong [Wisc.]. The Passenger Pigeon (Madison, Wisc.), 3: 33–36, Apr. 1941.

VIEHMEYER, GLENN. The present status of the Greater Prairie Chicken and Sharp-tailed Grouse in the sandhill region of Nebraska. Nebraska Bird Review, 9: 1–7, July 1941.—The only area in the State that now has much value as a breeding ground for these species.

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WETMORE, ALEXANDER. Notes on birds of the Guatemalan highlands. Proc. U. S. Nat. Mus., 89: 523–580, 1941.—Including critical notes on *Basileuterus*.

WHISTLER, HUGH. Note on two supposed new Indian races. Ibis, (14) 5: 312–314, Apr. 1941.—The races, *Dicaeum concolor unicolor* and *Melanocorypha m. kashmirica* lately described by Koelz are not valid.

WHISTLER, HUGH. Recognition of new subspecies of birds in Ceylon. Ibis, (14) 5: 319–320, Apr. 1941.—Ceylon races are described as new: *Dumetia hyperythra phillipsi, Kittacincla malabarica leggei,* and *Francolinus pondicerianus ceylonensis*.

WHITE, C. M. N. A new species of flycatcher from Northern Rhodesia. Bull. British Ornith. Club, 61: 48–49, May 22, 1941.—New is *Batis kathleenae*.

WILLIAMS, JOHN G. On the birds of the Varanger Peninsula, East Finmark. Ibis, (14) 5: 245–264, Apr. 1941.—In 1938, were great invasions of Lapp and Snowy Owls. Notes on eclipse and display of Steller's Eider.

WILLIAMS, NOEL J. Migration of Swainson's Hawks in western Iowa. Iowa Bird Life, 11: 35, June 1941.—Flock of two to three hundred birds noted.

WILLIAMSON, KENNETH. Early drawings of the Great Auk and Gannet made in the Isle of Man in 1652. Ibis, (14) 5: 301–310, pl. 5, Apr. 1941.—The plate reproduces the figure of the Great Auk, with historical notes.

WOLFSON, ALBERT. Light versus activity in the regulation of the sexual-cycles of birds: the role of the hypothalmus. Condor, 43: 125–135, May 15, 1941.—The hypothalmus "seems to be that part of the nervous system which regulates the time of breeding and of migration."

WOODBURY, ANGUS M. Bird habitats of the Salt Lake region. Audubon Mag., 43: 253–264, figs., June 1941.

ZIMMER, JOHN T. Studies of Peruvian birds. No. XXXVI. The genera *Elaenia* and *Myiopagis*. Amer. Mus. Novitates, no. 1108, 23 pp., May 14, 1941.—With critical remarks and descriptions of five new races from South America.

ZIMMER, JOHN T. Studies of Peruvian birds. No. XXXVII. The genera *Sublegatus, Phaeomyias, Camptostoma, Xanthomyias, Phyllomyias,* and *Tyranniscus*. Amer. Mus. Novitates, no. 1109, 25 pp., May 15, 1941.—Important distributional notes and descriptions of twelve new races from various parts of South America.

ZIMMER, JOHN T. Studies of Peruvian birds. No. XXXVIII. The genera *Oreotriccus, Tyrannulus, Acrochordopus, Ornithion, Leptopogon, Mionectes, Pipromorpha,* and *Pyrocephalus*. Amer. Mus. Novitates, no. 1126, 25 pp., June 26, 1941.—Distributional and critical notes, descriptions of four new races; substitution of *Scytalopus magellanicus opacus* nom. nov. for *S. m. obscurus* Zimmer, preoccupied.

ZIMMER, JOHN T. Studies of Peruvian birds. No. XXXIX. The genus *Vireo*. Amer. Mus. Novitates, no. 1127, 20 pp., June 26, 1941.—Reviews the vireos of the *olivaceus* and *gilvus* rasenkreise in South America with descriptions of five new races.

ZIMMERMANN, R. Z., JR. [Photographing Ospreys in Rhode Island.] Nat. Hist. (New York), 48: 62–63, 3 figs., June 1941.

CONSERVATION NOTES

By Francis H. Allen

The regulations for the hunting of migratory birds are 'liberalized' in some respects for 1941 and tightened in others. Canvas-backs and Ruddy Ducks are no longer limited to those in the daily bag of ten ducks, the possession of one Wood Duck is allowed in fifteen of the States, and six Blue Geese may be killed in a day if no other geese are taken; but, on the other hand, Wilson's Snipe are given complete protection, the seasons on Mourning Doves are reduced to forty-two days in each zone, and the White-winged Dove seasons have been drastically cut from one month to half a month in Arizona and from two months to ten days in Texas. There is a new experiment in the special limitation of goose bags in those counties in North Carolina, Illinois, and California, where concentrations have led to unduly heavy shooting. The Wood Duck regulation is admittedly an experiment, too. This species is frequently shot by mistake by gunners who have no intention of breaking the law, and in these cases the bird has been thrown away. The U. S. Fish and Wildlife Service is anxious to discourage the shooting of Wood Ducks, and the permission to include one in the daily bag is only an allowance for accidental killing. The hunter may be presumed to have learned his lesson after picking up a single Wood Duck, and that bird by its appearance in the bag may save the life of a duck of some other species that would otherwise be shot to complete the quota of ten. Another experiment is the prohibition of the killing of Snow Geese in Idaho, where, it seems, hunters have sometimes shot Trumpeter Swans under the impression that they were firing at geese! In spite of strenuous efforts on the part of some hunters, the regulations still prohibit the use of baiting and live decoys.

Conservation-minded ornithologists—which means, of course, all ornithologists—may be thankful that Dr. Gabrielson's organization, with its intimate knowledge of wildlife facts and conditions and its long-term view, has the final decision on these perplexing matters of seasons and bag-limits, and that not even a Congressional committee can dictate its policies.

The menace of oil pollution has taken a new form in the blow-outs of submarine wells on the Texas Coast. Director Baker of the National Audubon Society reports in the July–August number of the 'Audubon Magazine' what is being done to fix the responsibility for the resulting pollution and to prevent similar occurrences in the future. Apparently it was not known whether any actual damage had been done to the abundant bird life of those waters as yet, but the menace may be a serious one.

Fish-hatcheries under the control of the U. S. Fish and Wildlife Service are to be operated as wildlife sanctuaries, and no measures for the control of fish-eating birds are to be undertaken without specific authorization from Washington.

The 'Audubon Magazine' reports an unprecedentedly good breeding-season of the birds protected in the Texas maritime sanctuaries.

Dr. T. Gilbert Pearson reports in the May–June 'Audubon Magazine' the passage of the first national laws to protect wildlife in the Republic of Colombia. Certain species of birds, including Upland Plover, Robins, woodpeckers, herons, thrushes, and sparrows, get all-the-year-round protection for ten years, ducks and geese get a seven months' close season, and Woodcock can be shot for only four months of the year. This, of course, is only a beginning, but so far as it goes it is a good beginning.

CORRESPONDENCE

Birds and Wind

Editor of 'The Auk':—

The writer has waited a considerable period for the impression to disappear but it refuses to do so: he refers to the thought that airman Neil T. McMillan oversimplified matters in his article 'Birds and the Wind' (Bird-lore, 40 (6): 397–406, Nov.–Dec. 1938). That author said, "Anything suspended in air cannot feel its movement." But surely birds are not suspended in air; they can remain there only through muscular exertion that in the great majority of cases is strenuous.

Again he says, "A flying bird, which is essentially part of the wind, cannot be struck by it." But must we forget that birds are solid flesh of many times the specific gravity of air? How can they be "essentially part of the wind"? As to not being struck by it, the fact is that they are sometimes so struck and killed.

There was a shower of birds at Baton Rouge, Louisiana, in 1896, hundreds of individuals of numerous species falling to the ground, all dead (Osprey, 1 (4): 56, Dec. 1896). Two similar phenomena were reported six years apart in Cedar Rapids, Iowa, the later in 1890 when twenty-one species were identified among those falling during a severe rainstorm (Oölogist, 7 (6): 109–110, June 1890). Over a considerable area about Lincoln, Nebraska, in 1922, large numbers of birds fell to the ground dead. Their plumage was not wet (C. G. Gammon, letter of March 3, 1922).

McMillan goes on to say, "Even if he rides a hurricane that is spinning at well over a hundred miles an hour, the bird will feel not an ounce more of pressure or have a single feather ruffled." I will let the assertion be answered by another written, presumably, by an expert on aviation. It is: "Pilots give thunderstorms a wide berth, if possible, for within their cores often lies turbulence in which no airplane can live" (Time, 37 (15): 19, April 14, 1941).

Our author admits that, "Long dirigibles, slow for their size, have been literally sheared apart when straddling strong opposing currents" and goes on to say, "It is possible that birds receive painful wrenches under like conditions." This should be recognized as a masterpiece of understatement.

The reviewer believes that ornithologists will do well to retain their traditional belief in the importance of wind in the bird world. Many stragglers have been recorded as birds blown off their wonted courses by the wind and in all probability that explanation is correct. Wind is a visibly unfavorable factor in the everyday life of birds, as we see them fly low, or collect in sheltered places, to escape its force.

Some of the most expert flyers seem to enjoy a gale but the majority of birds shun the wind. Does it then become their great and good friend, once they launch into protracted flight? The probabilities seem to be against that conclusion.

W. L. McAtee

U. S. Fish and Wildlife Service.

Presentation of Nesting Data

Editor of 'The Auk':

Data on attentiveness of adults at the nest and frequency of feeding young are a necessary part of any study of nesting behavior. At present there seems to be a need for some agreement as to the methods of organizing and analyzing such data for publication. Only if methods are standardized can the data be of greatest

value to future workers. The available literature on the subject, while extensive, defies thorough and consistently comparative summarization.

An attempt will be made here to provide a basis for the organization of data on attentiveness and feeding. The various topics on which information is to be sought will be outlined and accompanied by suggestions as to final analysis. The proposed system of summarizing and presenting data is adapted from the method used in a recent study (Pitelka, 1940: 11–12). Other studies should be consulted for a broader perspective of the problems involved; the papers of Baldwin and Kendeigh (1927), Hann (1937), Nice (1932, 1937), and Moreau (1939, 1940) contain suggestive discussions, tables, and graphs.

Attentiveness.—By attentiveness, we refer to the actual time spent at the nest by either or both members of a pair and to the periodicity of such time (Baldwin and Kendeigh, 1927: 216). One or both sexes exhibit sequences of attentive and inattentive periods; and, in turn, if both sexes are attentive, the nest receives a sum of attention from the combined activities of the members of the pair. Thus, for a complete analysis of this phase of breeding behavior, the following details are necessary:

1. Number of attentive and inattentive periods per total time of observation. (Use a single day or large fraction thereof as a unit. The problem of time units is discussed below.)
2. Mean length of respective periods together with extremes. (The mode may be added if extensive data are available; see Moreau, 1939: 113; 1940: 239.)
3. Hourly percentages of attentiveness vs. inattentiveness; daily percentages.
4. Analysis of the data provided by 1, 2, and 3 for hour-to-hour changes, day-to-day changes, and differences between various stages of the breeding cycle.
5. Determination of differences between sexes *per se;* the relation of each sex to total attentiveness and participation therein.

For clarity, compactness, and convenience to future workers, the data subjected to the above analyses should be organized in table form. (This, of course, applies also to feeding data considered below.) Graphs should merely *supplement* the tables.

Here is a suggested tabular organization of data on attentiveness. The figures used are hypothetical. The basic organization may, of course, be modified according to the relations of the sexes in the particular species under observation.

Time-advance of nesting: Incubation, 5th day (June 15, 1940)
Length of observation: 5 hours (8 a.m.–1 p.m.)

1. Both sexes:
   - Attentive periods:
     - Number, 7
     - Average time, 30.0 minutes
     - Extremes, 10 to 50 minutes
     - Percentage of total time, 70%
   - Inattentive periods:
     - Number, 8
     - Average length of time, 10.3 minutes
     - Extremes, 5 to 15 minutes
     - Percentage of total time, 30%
2. Male } Repeat under each of these as under 1.
3. Female }

Feeding.—An analysis of frequency of feeding young should include the following details:

1. Total feeding visits (per day or large fraction thereof) resolved into:
   a. Number of visits per hour (mean and extreme).
   b. Length of intervals between feeding visits (mean and extremes).
   c. Number of nestlings fed per visit (mean and extremes).
2. Analysis of data provided by part 1 for hour-to-hour changes, day-to-day changes, differences between various stages of the breeding cycle.
3. Sexual differences: feeding visits of male and female to be analyzed in the same manner as total feeding visits (parts 1 and 2).

Data on feeding may be organized in tabular form as follows:

Age of nestlings: 4 days (June 27, 1940)
Periods of observation: 5 hours (8 a.m.–1 p.m.)
Number of nestlings: 3
1. Total feeding visits, 8
   Average no. per hour, 1.6
   Extremes, 1–3
   Intervals, 6
      Average length, 40 minutes
      Extremes, 5–50 minutes
   No. of nestlings fed per visit:
      Known instances, 8
      Average, 2
      Extremes, 1–3
2. Male: Total feeding visits } Repeat under each as in 1.
3. Female: Ditto }

The need for modification of this basic tabular form will, of course, arise according to the problems encountered. Thus, feeding of young may be cyclic with more or less long periods between the feeding periods, as 60–150 minutes of inattentiveness vs. periods of active feeding once every 3–25 minutes in the case of the Belted Kingfisher, *Megaceryle alcyon* (Mousley, 1938: 12); here the final figure of average number of feedings over a long period of time is of limited value. Thus, where there is an alternation of active feeding periods with rest periods, it would be more nearly accurate to add up feedings for the definite feeding periods and then divide by the total time of the latter; the resulting figure would be number of feedings per unit time of active feeding, and to this would be added a summarization of the long intervals of inattentiveness (average and extremes) to complete the analysis.

General Discussion and Suggestions

Additional points to be noted while studying attentiveness and feeding are: (1) total number of visits to the nest as against actual feeding visits; (2) number of pieces of food or 'morsels' brought at a visit; (3) nest sanitation; (4) number of brooding visits during the nestling stage and their relation to feeding rhythm, time of day, and changes in environment; (5) variation in kind of attentiveness given the nest (*i. e.*, actual brooding as against mere perching at the nest). In each of these points, attention should be paid to sexual differences and to notable changes during stages of the breeding cycle.

Time units.—In both attentiveness and feeding, it seems best to use one day as the basic unit in summarizing hourly percentages and rates, respectively; that is,

the data collected within one day should be summarized as against all other days rather than thrown together with several days' observations. In many species, incubation, feeding, and brooding rates change as the breeding cycle advances. If, however, there is good evidence for the absence of appreciable day-to-day changes, such data may be combined. Or, if data on daily rates have been given, significant facts may be obtained from summarizing and comparing segments of the data, *e. g.*, average feeding rate during the first as against the second half of the nestling period.

In studying swallows and swifts, Moreau (1939; 1940) uses a 200-minute unit to express feeding rate. This may be satisfactory for such species as swallows, which feed their young comparatively frequently; but for slower feeders, a longer period is needed. It seems more generally practicable to retain the hour unit for expressing feeding rate, but observations should extend over at least 5–8 hours.

Fragmentary observations of processes as feeding and attentiveness, the rhythms of which are discernible only over long periods, are of little value and should be subordinated to data on all-day or at least half-day observations. Emphasis should be weighed accordingly, for the writing up of fragmentary observations often takes more space than that of complete observations.

The above suggestions, if adopted by students of breeding behavior, should result in at least a partial standardization of published data. This should lift such details out of mere statistics and render them usable to future workers. Many facts of significance in general avian biology can be derived from comparable numerical data on attentiveness, feeding, and associated phenomena among different species.

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Acknowledgment is gratefully made to Mrs. Margaret M. Nice for critical reading of the manuscript.

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OBITUARIES

ARTHUR COPE EMLEN lived for the greater part of his life amid the pleasant surroundings at Awbury, in Germantown, Pennsylvania, where he was born on April 9, 1882. Through his mother he was related to the great naturalist, Edward Drinker Cope. A deep love of Nature, developing at an early age, went hand in hand with his subsequent profession of landscape engineering. From boyhood he had been a devoted friend of Dr. Witmer Stone's, and had been associated with him in the Delaware Valley Ornithological Club since 1897. During late years he had probably been Dr. Stone's chief intimate. After Dr. Stone's passing in 1939, Arthur Emlen doubtless filled his place in the D. V. O. C. as nearly as any member possibly could. He had served as vice-president from 1933 to 1936, and as president from 1936 to 1938, and he was especially active in the field trips of the Club. He was much more inclined to derive enjoyment from quiet communion with Nature than to spread his observations on the printed page.

On graduating from Germantown Friends' School in 1901, Arthur Emlen enjoyed a summer of travel and bird study in England. He became an Associate of the American Ornithologists' Union in 1921, and was particularly fond of attending its annual meetings, going as far as Charleston for this purpose in 1937. Of late he had served as secretary of the Ludwick Institute, which for many years has been providing free public lectures on natural history in cooperation with the Academy of Natural Sciences of Philadelphia. His interest in, and efforts in behalf of, Nature education brought him recognition in the form of election to the Board of Trustees of the Academy of Natural Sciences in 1940. He succeeded Dr. Stone as president of the Wissahickon Bird Club, and from 1935 to 1940 he had been president of the Germantown Historical Society.

The end came suddenly on January 26, 1941, at Jacksonville, Florida, shortly after his departure for a vacation trip in the South. A minute adopted by his fellow-members of the committee in charge of the Friends' Free Library in Germantown refers most fittingly to 'his kindliness, his sincerity, his modesty, his selflessness, his good sense.' But it is scarcely possible with mere words to do full justice to the memory of such a remarkably fine man and faithful friend as Arthur Emlen was.—FRANCIS HARPER.

GIDEON MABBETT.—More than fifty years ago appeared a brief note in 'The Auk' for October 1890, pp. 410–411, entitled 'A Query in regard to the Least Tern.' The author, Gideon Mabbett of Rodney, Mississippi, wrote to the Editor of 'The Auk' as follows: "I wish to inquire about a peculiarity in the nesting habits of the Least Terns or, as they are commonly known here, the 'Little Sea Gulls.' They generally arrive here about May 6 (this year, May 13) to breed on the sand bars of the Mississippi River. If the water is off the bars they begin laying about the middle of June, and they continue to lay until August, for I have found their eggs as late as the middle of the latter month. . . . Upon examining the eggs you will find perhaps half of them have a spot of water on them. How did it get there? Is it put there by the parent bird, and if so, for what purpose?" The writer never received an answer to his inquiry for he died August 15, 1890, and was buried in an unmarked grave in the cemetery at Rodney, a few weeks before his letter was published.

Little is known of Mabbett's history or personality and for the following facts

thanks are due Mr. Malcolm Gardner of the National Park Service of Jackson, and Judge Jeff Truly of Fayette, Mississippi. Mabbett was a bachelor and at the time of his death was apparently about seventy years of age. He was born in England, probably in Liverpool, and while still a boy, came to the United States prior to 1830. He evidently served in the Confederate Army. Local records in 1858 mention G. C. Mabbett as subject to military duty and at the close of the war give the name as Gideon Mabbett and still subject to military call.

He acquired a farm near Rodney in 1874 where he lived in a three-room house, two rooms of which were filled with natural-history specimens. He was a successful trapper and taxidermist and was apparently prominent locally, for some time after 1875 he was elected justice of the peace for his precinct. In 1884 and 1885, Mabbett sent notes on bird migration to Professor W. W. Cooke and at the Washington meeting of the American Ornithologists' Union he was elected an Associate member, the first member of the Union in Mississippi. He left few papers and his only contribution to 'The Auk' was the note mentioned above. Some of his specimens were acquired by the Agricultural and Mechanical College at Starkville, now know as the Mississippi State College.—T. S. Palmer.

NOTES AND NEWS

Bent's 'Life Histories'

Readers of 'The Auk' and others will be interested to know that the fourteenth volume of Arthur C. Bent's well-known 'Life Histories of North American Birds,' to include the flycatchers, larks and swallows, will go to the printer very soon, although it may not be published until some time early next year, owing to the congestion in the Government printing office. The fifteenth volume, covering the Corvidae and Paridae, is in manuscript and will go to the publishers next fall. Work on the sixteenth volume, to contain all the birds included in the Sittidae to Mimidae of the 1931 edition of the 'Check-list,' is now starting. Mr. Bent wishes to thank all former contributors for the valuable material they have sent in even though all of it could not be published for lack of space. He would be glad to receive as soon as possible, notes, photographs or other data on the species to be covered in the next volume in order that these may be included. All such contributions should be sent to Arthur C. Bent, *Taunton, Massachusetts.*

Walker Prizes in Natural History

Under the terms of the will of the late William Johnson Walker, the Boston Society of Natural History annually offers two prizes for the best original and unpublished essays submitted on subjects selected by a committee. For the 1942 competition the essays may be on any subject in the field of ornithology. For the best memoir a prize of $100 may be awarded and for the next best a prize of $50. Manuscripts must be in the Secretary's hands by May 1, 1942. For details as to the conditions of the competition, apply to the Secretary, 234 Berkeley St., Boston, Massachusetts.

Captain Delacour in this Country

Everyone interested in birds who has visited France within the past twenty-five years has gone to see Jean Delacour at his park at Clères, near Rouen. As a zoölogical park, Clères is now dead. The chateau, with its magnificent collections and its library, was gutted by fire before the war. The park is now pock-marked with bomb craters, the birds either dead or sold. Four men, as well as many of the birds and animals, were killed by bombing and machine-gunning from the air, and the German troops, coming later, looted the houses and wrought much damage.

Jean Delacour, who has entertained so many of us so kindly at Clères, is now in New York, working as an adviser to the New York Zoölogical Society, and has been appointed an extraordinary member of the Zoölogical Society of London for the duration of the war. He writes that steps have been taken toward the publication of the next number of 'L'Oiseau,' both in the occupied and the unoccupied zones of France. It is probable that there will not be an International Ornithological Congress for several years. Mr. Delacour is the Secretary-General of the International Ornithological Committee, as well as President of the International Committee for Bird Preservation. Any inquiries on matters pertaining to these committees should be addressed to Mr. Delacour, New York Zoölogical Society, Bronx Park, New York City.

Retirement of Dr. Oberholser

Dr. Harry C. Oberholser, internationally known ornithologist, after forty-six years of active duty with the U. S. Biological Survey (now the Fish and Wildlife Service) retired from Government service on June 30 of this year. He will continue his scientific work, however, as Curator of Ornithology at the Cleveland Museum of Natural History, thus by a curious coincidence taking over the duties of Dr. John W. Aldrich, who has been selected to fill the vacancy in the Fish and Wildlife Service caused by Dr. Oberholser's retirement.

The Kansas City Ornithological Club

A year ago a group of ornithologists met at the Kansas City Museum and organized the Kansas City Ornithological Club with headquarters at the Museum. It is planned to hold four meetings a year for the presentation and discussion of papers on ornithology. Undoubtedly the work of this new organization will prove stimulating to those in the region interested in the study of birds.

Reports of the Bird Protection Committee

Reprints of the 'Reports of the A. O. U. Committee on Bird Protection,' for a number of years past are still available to those who may wish to keep a file complete or to preserve a record of the work of the Committee. For certain years the number of copies available is small. Persons wishing to receive back reports from 1930 to 1939 should send a self-addressed envelope and postage to Mr. Victor H. Cahalane, U. S. Fish and Wildlife Service, Washington, D. C.

A Biography of Louis Agassiz Fuertes

Material for a biography of the late Louis Agassiz Fuertes, naturalist and bird artist, is being collected by his daughter, Mrs. Mary Fuertes Boynton, R. D. 3, Trumansburg, New York. She is eager to have letters written by Louis Fuertes, as well as anecdotes and personal recollections. Letters sent to her will be copied and returned promptly.

Postponement of the Tenth International Congress

The officers charged with the arrangements for the Tenth International Ornithological Congress, scheduled to have been held in the United States in 1942, announce that the proposed meeting has been indefinitely postponed.

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